SEP 5 1923

OFFICIAL JOURNAL OF THE AMERICAN COLLEGE OF SURGEONS

ANNUAL SUBSCRIPTION: UNITED STATES AND CANADA, $12.00; FOREIGN, $14.00.

Volume XXXVII SEPTEMBER, 1923 Number 3

Surgery, Gynecology and Obstetrics

WITH

International Abstract of Surgery

EDITORIAL STAFF

FOR AMERICAN COLLEGE OF SURGEONS

William J. Mayo, M.D.

Albert J. Ochsner, M.D. John M. T. Finney, M.D.

George W. Crile, M.D. Harvey Cushing, M.D. J. Bentley Squier, M.D.

George E. de Schweinitz, M.D. John L. Porter, M.D. T. J. Watkins, M.D.

E. Wyllys Andrews, M.D. Frederic A. Besley, M.D. W. R. Cubbins, M.D.

George E. Armstrong, M.D. Rudolph Matas, M.D.

FOR THE BRITISH EMPIRE

Sir Arthur Mayo-Robson, K.B.E., C.B., C.V.O., D.Sc.

Sir Berkeley Moynihan, K.C.M.G., C.B. J. Rutherford Morison, M.B., F.R.C.S.

Sir Harold J. Stiles, K.B.E., F.R.C.S. (Edin.) Thomas W. Eden, M.D., F.R.C.S.

Sir William de C. Wheeler, M.D., F.R.C.S.I.

Franklin H. Martin, M.D., Managing Editor

Allen B. Kanavel, M.D., Associate Editor

EDITORIAL AND BUSINESS OFFICES: 30 N. Michigan Ave., Chicago, Illinois, U. S. A.

PUBLISHERS FOR GREAT BRITAIN: Bailliere, Tindall & Cox, 8 Henrietta St., Covent Garden, London, W. C., England

Clinics on INSULIN from the MAYO CLINIC

Just one feature of the Medical Clinics of North America

SAUNDERS, *Publishers* SEE PAGE 13

Entered as second-class matter May 22, 1913, at the postoffice at Chicago, Ill., under the Act of Congress, March 3, 1879.

Published monthly. Copyright, 1923, by The Surgical Publishing Company of Chicago.

Clinical Congress of the American College of Surgeons, Chicago, October 22-26, 1923

EVERY SURGEON NEEDS IT

BRADY'S POTTER-BUCKY DIAPHRAGM

No surgeon should operate without the best information on internal conditions that can be secured only when a Potter-Bucky Diaphragm is used in the X-Ray Laboratory. You should insist on your X-Ray man at least TRYING one to assure himself and yourself of the truth of this.

Gives especially fine detail on heavy parts such as spine, kidney, gall-bladder, pelvis, etc., impossible to secure in any other way. THE GREATEST AID TO FINE RADIOGRAPHY EVER PRODUCED. The smallest, neatest and most accurate Bucky made.

New model with many improvements, price $250.00, less 10 per cent cash discount for prompt payment. Try it and be convinced.

EVERYTHING IN X-RAY SUPPLIES

We carry a large stock of all X-Ray supplies, including Duplitised Films, Plates, Intensifying Screens, Developer, Dental Film Mounts, Developing Tanks, Coolidge Tubes, etc. Get our Price List and Discount before buying. Prompt shipment, always.

GEO. W. BRADY & CO., 756 So. Western Ave., Chicago, Ill.

RADIUM

STANDARD CHEMICAL CO.

"Know the Company from Which You Buy"

An Important Point in Our Service

IN our monthly courses of Lectures at Pittsburgh, two entire days (preceding the lectures on radium-therapy) are devoted to a comprehensive presentation of the fundamentals of the physics of radioactivity as these relate to the therapeutic use of radium.

Some of the important topics covered are:

1. The nature of radioactivity—
2. The nature of alpha, beta, and gamma rays—
3. A dark-room demonstration of the properties of the rays—
4. The absorption of the rays in matter, and the effects of distance, cross-fire and implantation on ray intensity.

The user of radium should not underestimate the importance of a proper understanding of the physics of radioactivity.

RADIUM CHEMICAL CO.

PITTSBURGH, PA.

BOSTON NEW YORK CHICAGO SAN FRANCISCO DALLAS

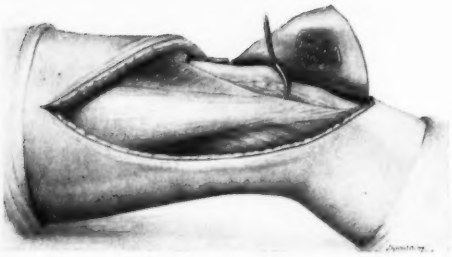


Fig. 31.

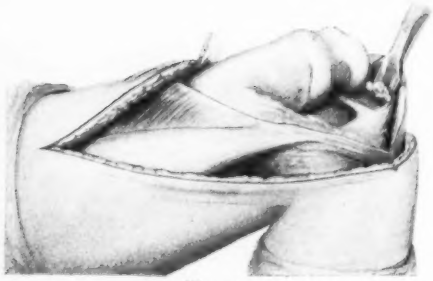


Fig. 32.

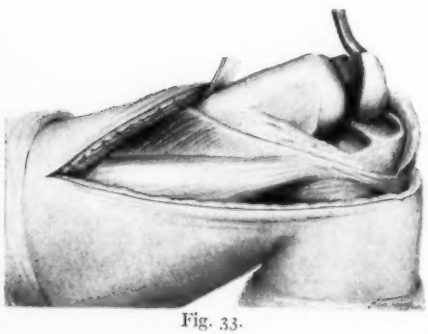


Fig. 33.

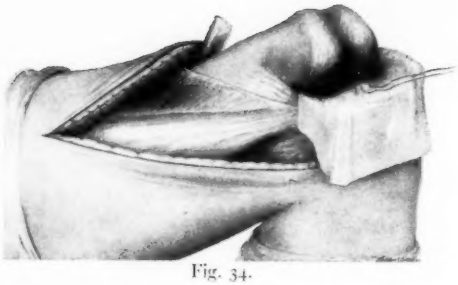


Fig. 34.

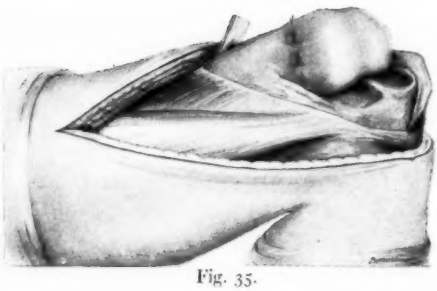


Fig. 35.

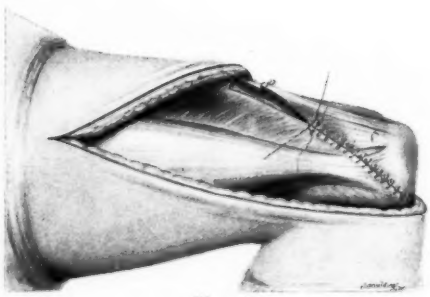


Fig. 36.

Fig. 31. Displacement of the patella with inner capsule inward and division of ankylosis.

Figs. 32 and 33. Luxation of the joint and remodeling of the femoral and tibial surfaces. Note the exaggeration of the spine of the tibia.

Fig. 34. Attachment of the fascial flap to the posterior capsule.

Fig. 35. Completion of the suture about femoral end.

Fig. 36. Suture of the capsule and elongated quadriceps.

SURGERY, GYNECOLOGY AND OBSTETRICS

AN INTERNATIONAL MAGAZINE, PUBLISHED MONTHLY

VOLUME XXXVII SEPTEMBER, 1923 NUMBER 3

MOBILIZATION OF ANKYLOSED JOINTS[1]

BY W. RUSSELL MACAUSLAND, M.D., BOSTON
Surgeon-in-Chief, Orthopedic Department, Carney Hospital

INTRODUCTION

MUCH progress has been made in the surgery of bones and joints in recent years, due largely to the extraordinary perfection of technical methods and the persistent efforts of a few able leaders. Probably no section of this field has occupied so much interest and effort as the surgery of stiff joints.

The best teaching, until very recent years, dealt almost entirely with the proper position in which a joint should be allowed to ankylose so as to permit the best function. The shoulder *stiff in abduction* is certainly much better functionally than the shoulder stiff at the side of the body; the knee *stiff in almost full extension* is undoubtedly far less of a disability than the knee fixed in marked flexion. And yet, with the gradual development of surgical technique, certain pioneers in joint surgery have tried to increase function by different methods.

Although the mobilization of ankylosed joints was at first, and is even now, attempted by only a few surgeons, several good results arising in a sea of failures led the pioneers onward to develop this new field of surgery. Foremost among them is the late John B. Murphy, of Chicago, to whom we pay a tribute of admiration for his constructive efforts founded on a vast accumulation of clinical and scientific material. The results of operations have been sufficiently definite so that various methods may be presented with the assurance that they will continue to be more or less standard in future work. Today Payr, Putti, and Baer, persisting in the face of adversity, have opened this limited field of surgery so that carefully trained operators with highly developed technical skill can now present results which show only a small percentage of failures. The risk to life is very low and the margin of good results reasonably certain.

ARTHROPLASTY NOT AN EXCISION

Arthroplasty, or the operation of mobilizing ankylosed joints, is not an excision. Murphy has well said: "Arthroplasty to be functional must be stable, and excision of joints results always in flail joints." A flail joint cannot be considered a proper result from a plastic operation. Excision has no place in the surgery of weight-bearing joints, save to obtain ankylosis, nor would it be used in non-weight-bearing joints if it were not that flail joints may be stabilized by means of light apparatus.

Those who attempt to mobilize ankylosed joints must approach the work well trained, must show great technical skill, and, above all, must exercise judgment in their selection of cases, if they would qualify for this work.

I present the subject of arthroplasty to you, therefore, in order to stress these important points:

[1] Presented before the International Congress of Surgery, London, July 18, 1923.

1. That excision of a joint does not constitute an arthroplasty;
2. That highly developed technical skill is absolutely necessary;
3. That the judgment in the selection of cases is very difficult.

Types of Ankylosis—Infectious, Non-Tuberculous, Traumatic

Ankylosis is the result of an infectious process or traumatism. The latter is usually a fracture dislocation with wide separation of fragments, followed by excessive callus. The ankylosis in these traumatic cases is usually a firm fibrous formation, although occasionally a true bony ankylosis may result.

The infectious process may be either acute or chronic. In the former case the causative agent is usually the streptococcus, the pneumococcus, or the gonococcus. In these infections the onset is sudden, and the course severe, ending usually in a bony ankylosis. We may, on the other hand, have a slow, insidious, polyarthritic process. The focus of infection is situated elsewhere and the joint condition is caused by the hæmotogenous deposits in the joint, either of attenuated bacteria or of toxins. The primary focus is often difficult to locate. The ankylosis results from adhesions both within and without the joint, and is, at least at first, fibrous in character.

Murphy (120, b) believed every type of non-traumatic joint inflammation to be the metastatic manifestation of primary infection in some other part of the body. Sometimes long periods elapse between the primary infection and the secondary arthritides. Gonococci metastases usually occur in 18 to 20 days, staphylococci in 10 to 14 days, and streptococci and colon bacilli in 8 to 10 days. These metastatic joint infections are initiated with a chill, and are not rheumatic in character.

The synovia is first involved; the serous surface of the membrane is destroyed in large and small areas. Up to a certain extent it may be repaired. In extreme erosions subserous tissues bridge over the spaces between the serous erosions, and adhesions result. The gonococcus, pneumococcus, and streptococcus may produce this condition. Pathology shows thick, porky infiltrations of the synovial membrane, œdema of the subserous surfaces, and injection of the surface toward the joint. The cartilage is not affected at an early date. In repair, the proliferated epitheloid cells become obliterated.

Causes and Extent of Ankylosis in Relation to Mobilization

It is important to emphasize the necessity of determining the cause of ankylosis, for it makes a great difference whether the ankylosed joint is the result of fracture or of disease, or whether it is congenital.

Infections, either acute or chronic, do not constitute a contra-indication to the operation, provided that the process has not been tuberculous or is not active. It is well to point out that many joints, apparently firmly ankylosed even by a bony bridge, may retain active infectious agents for a year or even two years. A tuberculous joint, even when ankylosed firmly, may retain small walled-off foci throughout life, and, therefore, except in cases of great rarity, should be considered a direct contra-indication to any mobilizing.

Certain infections cause great destruction of bone and injury to the soft structures of the joint. Where such destruction is extensive, or where there is marked scarring of the tissues, a difficult operation may be expected.

Occasionally deformity of such extent is present as to warrant the correction of the deformity before arthroplasty is attempted. The hip, for instance, ankylosed in marked flexion and adduction, will present a very difficult operative problem, unless the deformity is first corrected by a preliminary procedure. Marked flexion of the knee, although not so important, may also necessitate a preliminary intervention.

In general, I have found bony ankylosis easier to deal with than partial or the so-called fibrous type.

Indications and Contra-Indications for Arthroplasty

Any ankylosed joint might be considered for arthroplastic procedure, but there are definite limitations, and therefore we come to have certain fundamental indications for arthroplasty.

Major joints. First, two stiff hips will indicate arthroplasty on one hip, or possibly both. Second, two stiff elbows will present the same indication. Third, two stiff knees will present a definite indication for an arthroplasty on one side, at least. Fourth, combinations of hips and knees in the same individual, a condition not infrequently seen in multiple arthritis, is a very definite indication for attempting to mobilize one or more joints. The surgeon considers in all of the above indications the anatomical and occupational status of the patient.

Minor joints. Among the lesser joints which may be considered properly a subject for intervention are: first, stiff shoulders; second, stiff fingers; third, stiff wrist (a very rare subject for arthroplasty); fourth, the jaw, which demands arthroplasty.

In general it may be said that definite indications naturally rest with the judgment of the surgeon, but must depend to a large degree upon the patient. One stiff elbow, for instance, in some individuals is a very slight disability; in others, it is of supreme importance. It is necessary, therefore, that each case be considered upon its merits and not upon the mere desire of a patient to be able to move a joint. There should be considered constantly the question of whether the deformity may be actually the principal source of disability, and whether, as has been mentioned before, correction of deformity may not give sufficient relief to the patient.

Methods of Treatment—General Survey Prior to Arthroplasty

Many means have been used to gain mobility in ankylosed joints. Previous to 1860, *brisement forcé* was the general method of treatment. It is still in use, and in properly selected cases the results are good.

J. Rhea Barton (11), of Philadelphia, in 1826, first attempted pseudoarthrosis in the case of ankylosis of the hip joint. The operation consisted of an osteotomy through the femur above the trochanter and the attempt to prevent bony union by movement. The patient lived 6 years with a good weight-bearing leg and some motion in all directions.

Rodgers (155), of New York, modified this method in 1830 by removing a disc of bone from between the trochanters. He obtained a more satisfactory result. Bérard (13), Esmarch and Rizzoli, both reported by Murphy (120, g), and McIlhenney (114) used similar methods for treatment of the jaw.

In 1880, Wolff (197) recommended a method which he called arthrolysis, which consisted of chiseling through and dividing all fibrous or bony adhesions, without resection of the articular extremities that had been restored to their normal position. Wolff claims favorable results in nine cases, four of ankylosis of the fibrous type and five of the bony type. It is probable that he did not treat a true bony ankylosis.

Kocher (103) suggested dislocating the joint for a short period after arthrolysis. No success is reported.

Actual resection has a few advocates. Good functional results have been reported in a proportion of cases of ankylosis of the jaw, elbow, and hip. Koenig (104) recommended resection in wide luxation. Textor (178) in 1843 reported a case of ankylosis of the elbow in which there was full range of motion 6 years later. Ferguson (63) secured a weight-bearing limb by resection of the knee. Dautrelepont (45), Czerny (42), and others observed that a new joint cavity with synovial membrane and articular cartilage formed 3 years after resection. Sayre (161) and Defontaine (47) tried to fit bony ends after the fashion of an articulation. They obtained stability, but adhesions formed again. Dartignes (44) described a trochleariform osteotomy; he resected the joint surfaces with preservation of their form. The result was ankylosis again. Cavazzani (29) liked to spare the bone and soft parts for the preservation of the physiological function. He emphasized a transverse incision.

Painter (133) recommended excision, for in arthroplasty he feared the extrusion of the interposed material, or infection. Resection cannot, however, increase function in a weight-bearing joint, as the one essential—stability—is lacking, and, while resection in the upper extremity is practised and is as good as a poor arthroplasty, it does not measure up with a

good arthroplasty either in surgical technique or in functional result.

Very little has yet been done in the transplantation of half or whole joints. Lexer's (110) first case was to implant in a stiff elbow of gonorrhœal origin the patellar surface of the femur. The result was fibrous ankylosis. His next step was to use a transplant of the entire knee joint. The knee joint was fixed in acute flexion in bony ankylosis, resulting from articular suppuration after purulent osteomyelitis of the femur. He made an anterior flap incision, the soft parts remaining in contact with the flap. All lateral and posterior coverings were detached. A new joint, obtained from a limb amputated simultaneously for senile gangrene (without phlegmon), was fitted in. In this case he neglected to place tissue beneath the patella, thus necessitating a second interference. Fixation by plaster cast from toes beyond the iliac crest followed. Three months later the epiphyses were in firm union, the semilunar cartilage preserved, and the articular cartilage was smooth. A small spicule of bone was later excised and analyzed. The transplanted portion had become a part of the new organism.

The second case Lexer reported was a transplantation for bony ankylosis of a tuberculous knee joint. The entire joint was again taken from a freshly amputated limb. In both cases the extremity was somewhat shorter. The knee joint was in normal extension. Lateral motion was present in the second case. Both patients could bear their weight well when walking or standing. Lexer then aimed to obtain function by muscle plastic elongation of the efficient non-atrophic muscles.

Herzberg (83) reported four cases in which transplantation of joints was done after resection. Three of the cases were children.

Eloesser (60) reported a case of implanting a cadaveric joint consisting of three inches of tibia, fibula, and astragalus. The attendant dropped the implant during the operation, which necessitated heating it. Suppuration developed and the foot was amputated. Examination showed the tibia was invaded by new bone in all stages of formation. In a case of implanting a finger joint from the cadaver, 35 degrees active motion and 60 degrees passive were secured. Movement was improving at the time of the report.

Goebell (72) implanted a toe joint into a finger resected for severe arthritis deformans. A good movable finger resulted, and the patient, a violinist, resumed her profession.

G. T. Vaughan (185), of Washington, was unsuccessful in replacing a knee taken from the cadaver. The graft became the site of suppuration.

Kuettner (106) reported two cases of implantation of femoral neck and head, using the cadaver as the source of material. One patient walked without a cane and had considerable motion. An autopsy at death from vertebral metastasis, 1 year and 1 month after operation, showed the joint fixed to the femoral shaft by a narrow ring of bony callus. The whole graft was covered by a membrane similar to periosteum. The second case remained cured 3 years and 2 months. Local recurrence necessitated disarticulation of the hip.

Deutschlander (52) tried transplanting in a child of thirteen a graft containing the joint extremities of the femur and tibia with the greatest part of the joint capsule, menisci, and ligamentous apparatus. Ten months after the operation, the transplant was luxated and removed.

Oehlecker (126), in 1922, reported the outcome, after 6 years, of eight cases in which an entire joint was transplanted into a finger. In four cases the joint was taken from the patient himself and in others from another person. The results in the autoplastic cases were more successful.

Work with whole and half joints has been done by Sievers (169), Petraschewskaja (137), Katzenstein (97), and Buchmann (24).

There is much discussion in regard to the regeneration process. Axhausen (8) in 1907 proved that periosteum and endosteum of implants remained alive. Eloesser (60) believes regeneration takes place in part from the elements of the graft itself.

The cadaver material is easier to obtain than a living graft, but infection must be avoided. The joint is removed within 12 hours after death. The Wassermann test is used on the blood and part of the bone marrow

is incubated in broth. The joint is implanted in Ringer's solution for 24 hours. It is then freed of all adherent tissue and muscle.

In the operation a horseshoe flap is outlined and the bone is sawed close to the joint. The new joint is inserted by mortising and held in place by catgut. Traction is secured by adhesive plaster strips. A plaster-of-Paris splint is then applied. General passive motion is instituted in a week.

This surgical procedure seems at once radical and dangerous, and has not been generally accepted. Simple arthroplasty, without the use of bone transplants and with little use of any foreign heterogeneous material, has supplanted all such extravagant measures. Their interest is chiefly historical.

Various non-absorbable materials have been tried as the interposed material. Carnochan (27), of New York, in 1840, inserted a piece of wood in an ankylosed jaw. Orlow (130) in 1901 used gilded aluminum plates in two jaw cases. Roser (158), Pupovac (144), Huebscher (93), Hoffa (86), and others used magnesium plates and silver. Chlumsky (33) tried zinc and rubber, but reported no permanent results. Later he used absorbable plates of decalcified bone, ivory, and magnesium, but the results, on the whole, were not satisfactory. Gluck (70) and others inserted ivory pegs. Besides these materials, celluloid, gutta percha, and temporary packings of gauze have been used. Foederl (65) in 1903 used animal membrane or walls of ovarian cysts, but found that they caused suppuration, and re-ankylosis occurred.

Rechet (148) covered the ends of the resected bones in various joints with periosteal flaps.

Hofmann (87, a), in 1906, reported a case in which he transplanted periosteal flaps from the tibia to the resected ends of the bones of the elbow. He obtained full extension and flexion to 80 degrees.

Von Frisch (66) used periosteal grafts from the tibia in an elbow ankylosed from gonorrhœal arthritis. Only 25 degrees motion was obtained. The author attributed the result to lack of after-treatment.

Greiffenhagen (75) reported three cases in which periosteum was used in elbow joints.

A graft of joint cartilage was first used with success by Tuffier (183) in 1901 for a comminuted fracture of the upper end of the humerus. Judet (96) doubled the cartilage with a layer of bone.

Mauclaire (112) used cartilage from the astragalus to cover the rough ends. Later the X-ray showed these fused to the bone.

Weglowski (189), in 1907, reported a case in which he successfully used cartilage from the rib in an ankylosed elbow.

More recently cartilage grafts were used by Delagenière (48) after a resection had been done. The operation showed no advantage over excision, as some instability of the joint followed.

Gluck (70), in 1902, used skin flaps.

Diel (53) reported the use of reindeer tendon and the epiploon of a rabbit in a case of femoral-patellar ankylosis. In 10 months the patient could walk easily without a cane.

ARTHROPLASTY

History

Foreign substances are no longer used, and since 1900, fat, muscle, fascia, or specially prepared membranes have been inserted in the joints.

The first case of muscle interposition was in the jaw, where immobility often interferes with life. In 1860, Verneuil (186) interposed a piece of temporal muscle and fascia between the condyle and glenoid after resection. Helferich (80) and Ollier (129) developed the technique of muscle implantation and gave it general notice. In 1893, Helferich exhibited a child who had regained motion in an ankylosed jaw by use of a flap of temporal muscle. Lentz (108), Henle (82), and others repeated the operation, using muscle flaps. Both coronoid process and condyle of the inferior maxillary were removed by Bilczynski (17) and Hoffa (86), and a flap of temporal muscle inserted.

In 1895, Mikulicz (118) used a flap from the masseter muscle instead of from the temporal. Kusnetsoff (107) repeated the operation per-

formed by Hoffa and Bilczynski, using a masseter flap as the interposed substance. Rochet (154) and Schmidt (165), after the removal of the entire ramus, interposed a masseter flap.

Operations on other joints followed those of the jaw. In the treatment of the elbow, Quénu (146), Albarran (2), Nélaton (123), Delbet (50a), Murphy (120), Hoffa (86), and Schanz (162) used flaps from a muscle contiguous to the joint. Berger (15) in 1903 mobilized a fibrous ankylosis by inserting a flap of the anconeus which he sutured to the brachialis anticus. Huguier (94b) introduced in the radio-ulnar joint a layer of the posterior ulna.

Muscle flaps were then used by Rochet (154), Nélaton (123), and Hoffa (86) in ankylosis of the hip, and others used them in the knee.

Experimental Methods

Unfortunately the experimental work in arthroplasties on animals has been relatively small.

Experiments with living tissue have shown that it degenerates or is replaced by a fibrous tissue. Small cavities are formed during this process. Allison and Brooks (4) found that the end-results of simple resection of joint surfaces without interposition of a substance do not differ materially from cases in which the substance was inserted.

Murphy (120, g) destroyed joint surfaces and interposed flaps of fat and fascia. He claimed that the fat undergoes connective-tissue changes which facilitate the bursa formation.

Neff (122) reports only one successful case of four arthroplasties on dogs, using free transplants from the rectus aponeurosis. Three cases were ruined by wound infection. The successful operation on the knee showed new capsule had formed connective tissue between the tibia and femur, and that two bursal sacs had developed.

Davis (46) in his experiments on a dog found, at autopsy, that free fascia in the knee joint was adherent to the end of the femur and the material was viable. Putti (145, d) also used free fascia, and found the substance retained normal characteristics.

Kolazek (105) in five experiments on dogs excised a portion of the capsule and inserted homo-transplants of peritoneum. They healed and formed no adhesions.

Sumita (175) destroyed the joint surfaces of the knee, hip, and ankle of twenty dogs and interposed pedicled flaps of muscle, fascia, and tendon. The dogs were observed for periods of 21 to 244 days. Fibrous tissue and small cavities had formed, but the largest cavity measured only 1.5 centimeters in diameter.

Bolognesi (20), in a long series of experiments, followed the process of formation of periarticular nearthrosis. He believed that an enarthrosis or a true diarthrosis can be formed only when a foreign element is interposed, and that the means of covering the cavity had origin in the cartilage of the neoformation which covered the free fragments of the fracture.

Segale (167), in 1913, in experiments found that the joint capsule in a rabbit or dog reproduces itself from the surrounding tissues and forms a new capsule which limits the joint cavity and contains synovia. The reproduction of the joint surroundings is closely connected with the operative technique which provides for the preservation of those parts which assure a correct joint mechanism.

Ely (61) experimented on nineteen dogs, using no interposing material. Bony ankylosis developed in one case in 432 days.

Hohmeier and Magnus (90), in a series of experiments on dogs, found the end-results were the same with or without interposing substances.

Beye and Steindler (174) experimented on dogs and found no adhesions formed after mere scraping of the cartilage covering and inserting of fascia. Pedunculated muscle fascia was transformed into a connective-tissue pannus adherent to denuded areas of bone. There was complete transformation into connective tissue and no traces of original muscle fibers existed.

Experiments were then made using non-absorbable materials, but they were discarded.

Allison and Brooks (4) found that the chromicized pig's bladder suggested by Baer caused reaction in the surrounding tissues,

and adhesions formed. They experimented with silver impregnated fascia and found relatively little reaction in the surrounding tissues.

Phemister and Miller (139) obtained similar results in the elbows and knees of dogs, with or without the interposition of free or pedunculated flaps. The flaps largely broke down, and the resulting joints were alike in the three types of operation. They did not see how any appreciable amount of nutrition can be furnished by the circulation through the pedicle. They believed that the circulation in the surviving portions is through adhesions to the parts with which they come in contact.

Present Clinical Methods

The methods in use today, as outlined by Murphy (120), Payr (134), Baer (9), Allison and Brooks (4), Putti (145), and the writer (111), have in common the exposing of the joint surfaces, modeling of the bone-ends after the conformation of the normal joint, and the interposition of a substance to obstruct effectively bony union. They differ particularly in the substance interposed.

The two essential features of the Murphy treatment are the interposition of the pedicled fat and fascia flap and the application of traction. Murphy (120) emphasized the inclusion of the fat, as he believed it essential to a new joint foundation. It was his belief, too, that the flap was nourished through the pedicle. His technique in the different joints varied, not in principle, but as necessitated by the different joints. It will accordingly be treated later under each joint. The writer believes that pedunculated flaps are entirely unnecessary, and when covered with fat they interfere with the highest technique.

Baer (9) objects to the interposition of muscle or fascia for several reasons. He maintains that the structure of the joint is interfered with when a bulky substance is inserted; that too large an excision is required; that, if too little muscle or fat is interposed, ankylosis results; that the pain is severe, due to the pressure on the nerve-endings; that the motion obtained is generally unnatural in character; and that periarticular tissues are interfered with.

Baer advised chromicized pig's bladder as the transplanted medium. It is thin and flexible and conforms accurately to the surfaces of the modeled bones, and is tenacious enough to withstand disintegration for a period of from 60 to 100 days.

The use of Baer's membrane has not become universal on account of numerous failures and sloughing out of membrane, often weeks and months after the healing of wounds. Allison and Brooks (4) found that with Baer's membrane the reaction of the surrounding tissues was of such intensity that adhesions formed. In 1913 they recommended the use of silver impregnated fascia from which there was relatively little reaction.

In the use of the "free flap" as the interposing material, there is an opportunity to obtain the correct size, to determine the presence of a bursa, and to secure a good layer of fatty tissue. Putti (145) states that fascia will live after transplantation; there is, therefore, no need to use pedunculated flaps. He believes that the free fascia grows and is transformed into a tissue like the synovia. He covers the epiphysis completely with free aponeurotic flaps from fascia lata. One difficulty he has met in the use of these flaps is necrosis of the edges, a condition existing even in satisfactory cases.

Putti has been particularly successful in his operations on the knee. I shall treat his technique under the division on the knee joint.

Payr (134, b) advises the careful extirpation of the capsular tube leading to the nerve-endings; the removal of the masses of connective tissue is not enough. Under the influence of the rapidly resumed function, there develop in and between the interposed soft portion (fat or fascia, etc.) at first multiple, and later connected interstitial spaces which finally form a joint space. A new satisfactory capsular tube is formed out of the periarticular connective tissue in which other accessory ligaments may develop by simple mechanical exercises. The new joint contains a synovial-like fluid.

Payr has obtained the best results with pedunculated flaps and freely transplanted fat. In all cases Payr has found that the opera-

tion has increased the breadth of excursion of the joint motion. Patients with an ankylosed knee, leaving the hospital with 65 degrees active mobility, showed 90 degrees or more after a year or so. The movement is usually smooth and painless. The X-ray showed the newly formed joint to be smooth and sharply defined; there are no free bodies. From a functional point of view also the new joints are satisfactory. He advises being careful in operating for ankylosis of tuberculous origin.

Payr's technique is recommended by Wollenberg (196), who, however, warns against the general use of arthroplasty, as too often mobility is purchased at the cost of an unstable joint.

The writer (111, a) first used free fascia in an ankylosed elbow in 1908. In 1914 four cases of free fascia transplants with excellent stable joints resulting were reported before the Orthopedic Section of the American Medical Association in Detroit. A series of thirty-one cases of elbow arthroplasties was reported in 1921.

Ritter (reported by Thom, 179), Behn, reported by Harris (79), Kirschner (100), and others have also used free flaps.

ELBOW

Most joints, when stiff, can be placed in a position to function well. The position in which maximum function is obtained in the elbow is near 90°, and many surgeons advocate it in preference to a mobilized joint. But ankylosis of the elbow joint, even at this most satisfactory angle, has very objectionable features.

While function may be present if the elbow joint is ankylosed in flexion, it is never good function, and the arm is always in the way. Usually, too, ankylosis is found in extension of about 160 degrees, in which position the arm is awkward, although not unsightly. Given, then, an ankylosis of the elbow joint from any cause except tuberculosis, some type of mobilization operation may be considered indicated.

Resection, which is performed for the tuberculous joint in adult patients, is the operation which is usually thought of first. The results from this procedure are very unsatisfactory, as the joint becomes flail, weak, and usually requires external support in the form of a leather armlet with limited elbow-joint motion. Excision, therefore, is rather a crude surgical procedure, and the ultimate results from its use do not warrant its being considered for any condition except tuberculosis of the elbow.

For many years the writer has been working to improve the method of procedure in these cases, and has found that, with each improvement in the technique, a definite improvement in the function of the elbow-joint motion is obtained, until finally the operation which is at present employed, namely, a true arthroplasty, has been evolved.

A good arthroplasty gives a smooth gliding joint, so frequently emphasized by the late John B. Murphy. The range of motion is excellent, the strength approaches normal, the stability is normal, and the joint is painless and tends to stand rather severe work without showing arthritic changes.

To my mind, therefore, the operation of arthroplasty on the elbow is to be considered in a different category from the old operation of excision. However, I wish to emphasize four important points: first, the necessity for the proper selection of the case; second, careful preparation for operation; third, strict adherence to the technique of the operation; and, fourth, proper after-care. No arthroplastic method should be attempted until 2 years after an infectious process has been quieted down, and until at least 1 year after a traumatic ankylosis. These two groups include fractures, infectious arthritis, and a few neisserian joints.

Ankylosis of tuberculous origin requires other treatment, and arthroplasty is indicated in only the most unusual case.

There have been more arthroplasties on the elbow than on any other joints. One of the early cases of arthroplasty using a muscle flap was reported by Albarran (2). Ankylosis had followed operative reposition. A partial resection was done by which a good immediate result was obtained, but later ankylosis occurred again. A third operation was undertaken, which consisted of a resection of the olecranon and interposition of a muscle-fascia

flap of the triceps. After 2 years there was a range of motion from 65 to 115 degrees.

Nélaton (123), in a case of ankylosis following neisserian infection, resected an elbow and interposed a flap of the brachialis anticus. Two years after the operation, flexion and extension were normal, but pronation and supination were much decreased. Active extension required the weight of gravity.

In 1903, Quénu (146b) reported an arthroplasty of the elbow for an ankylosis following a severe trauma of the arm, consisting of a fracture of both bones of the forearm and destruction of the soft parts. After resection he interposed a tendon fascia flap. There resulted flexion to a right angle and good but incomplete extension. There was good pronation, but difficulty in maintaining an intermediate position. The patient died of pulmonary tuberculosis a few months after the operation.

Delbet (50, a) also reported mobilizing, in a girl of six, an elbow which had become ankylosed in infancy, resulting in complete atrophy of the arm. At his first operation he resected the joint without breaking up the ankylosis. Two months later, after re-ankylosis, he intervened again, removing the bony spicules that had formed 0.5 centimeter thick, from the humerus, radius, and ulna. Some fibers of the flexor carpi ulnaris were interposed. Chloroform mobilization was necessary a month later, but the final result was good, with flexion to a right angle and extension nearly complete.

Schanz (162), in 1904, reported a mobilization of a bony ankylosis following rheumatism. After chiseling through the joint, he enlarged the sigmoid fossa, removed a piece of the trochlea, and interposed a flap of fat from the under side of the forearm. Three months after the operation the arm could be used for ordinary purposes.

Murphy (120, a) first mobilized the elbow by his method in 1904, in a case of ankylosing arthritis. A pyriform flap of deep fascia was dissected from the posterior surface of the triceps. The flap was 4½ inches long by 2 inches wide at its upper end, and received its blood supply from a broad pedicle which remained attached to the muscle and fascia just below the level of the olecranon. After the bony parts had been remodeled, the fascia was drawn down and turned into the joint around the inner margin of the olecranon. The proximal portion of the flap covered the trochlea, lined the olecranon depression and the lesser sigmoid cavity, while the distal portion covered the external condyle. Subsequent events showed that the flap was not carried sufficiently high on the anterior surface of the humerus to permit adequate flexion of the joint. Five months later, the patient could pass his hand through an arc of 5 inches. Pronation and supination were about one-half normal. His second case was reported 2 months after operation. The hand could be moved through an arc of 3 inches and the elbow forcibly flexed to an acute angle and extended to 160 degrees. Pronation and supination were approaching normal.

Hoffa (86), in 1906, reported a series of arthroplasties, seven of which were on the elbow. One, using a magnesium plate, was unsuccessful, owing to formation of gas in the joint. A fistula resulted which closed only when the plate was removed. The operations in which fat, fat and fascia, and fascial flaps were used were all successful. In two of them, ankylosis followed scarlatina; in the others, gonorrhœal infection.

In 1905, Quénu (146, c) reported a third case in which there was great atrophy of the muscles. He used for a flap the inner part of the triceps sutured to the anterior ligament. Passive movements were begun in 10 days, and later electrical treatment was used. As active movement was incomplete at the end of 2 months, he made a second intervention to recover a part of the tendon of the triceps, of which a large portion had been sacrificed. He cut the portion interposed close to the bone. He could then ascertain that there was no adherence between the superior surface of the interposed segment and the inferior cut surface of the humerus. The same condition existed on the inferior surface. The tendinous segment had left a distinct cavity. The tendon of the triceps was sectioned and reinserted on a little fibrous flap previously dissected on forearm. Patient gained not quite complete extension, and flexion to right angle.

Dupuy (56), in 1905, reported five arthroplasties. Three were done by Jeannel, one by Kirmisson, and one by Launay. Jeannel used flaps of the brachialis anticus; Kirmisson, of the biceps; Launay, a flap from the anterior ligament and the brachialis anticus. In all cases good results were obtained.

Huguier (94, a), in 1905, reported two cases operated on by Nélaton with the interposition of a muscle flap. In one case he gained good motion. Huguier reported a third case by Ombrédanne, using the same method.

Pereira (135), in 1906, in an unreduced subluxation, resected the ends of the bones and interposed a flap of triceps muscle, with an almost perfect functional result.

Scudder (166), in 1906, 1907, and 1908, reported several successful cases in which he used Murphy's method.

In 1907, Bazy (12) reported a case in which he used a flap from the brachialis anticus. Nine months later, the function of the arm was almost perfect.

Ameyaga (5), in 1907, brought his method of treatment to general attention. The two main factors of his technique are the formation of a new socket in the humerus and the firm grasp of the humerus by the hook of the ulna. One difficult case he reported had a good success, the patient in 3 years working in a factory and carrying heavy weights.

Stein (173), 1907, cited three successful cases from Bier's clinic. Triceps flaps were used.

Wiener (194), in 1909, treated an elbow ankylosed as a result of fracture. A flap of fascia and subcutaneous fatty tissue from the triceps was inserted. Twenty days after operation, he broke up the adhesions. Eighteen months later, the patient could carry heavy bundles, and motion was improving.

Huguier (94, b), in the same year, mobilized an elbow, using a flap of brachialis anticus. In 16 months, the patient could touch his shoulder with the hand and extend the forearm to 150 degrees.

Cifuentes (35) reported, in the same year, a similar arthroplasty in which, 1 month after the operation, he obtained a good functional result, with normal movements.

Reiner (149), in 1910, reported a series of twenty-eight arthroplasties, twenty-five of which were given in full, with the after-results. Two others, recent cases, were reported with good immediate results. In three cases the histories were unknown. Of the others, nineteen had useful arms, although one was a flail joint which lacked power, but could be controlled by the muscles. The poor results in the other cases were due to extreme atrophy of the muscles, and to extensive resection of the diseased tissue. Re-ankylosis occurred in two cases. In one, it was due to operation too soon after trauma, a fracture luxation, and lack of after-treatment. In the other case, Reiner attributes the result to the disease, myositis ossificans.

Thom (179), in 1910, reported a case of ankylosed elbow operated on by Ritter. He used freely transplanted fascia lata as an insert after the parts had been made freely movable. On discharge there was 65 degrees flexion and 100 degrees extension. Pronation and supination, which were very slight before the operation, were unchanged.

Wille (195), in 1911, interposed supinator longus fascia, with good results, gaining 95 degrees motion.

Osgood (131), in 1911, reported a case of elbow operation, using Baer's membrane. Four months after operation, extension was complete, there was voluntary flexion to 120 degrees, and a little more than normal "lateral mobility." (Just what Osgood means by "lateral mobility" is hard to understand, as a good arthroplasty has none.)

Whitman (193) reported two cases of arthroplasty of the elbow in which he used Murphy's method.

Edmunds (59), in 1912, reported an elbow ankylosis following fracture, in which this method was also used. At the time of the report, active motion was not possible, on account of the great atrophy of the muscles.

Denk (51) reported two of von Eiselberg's cases, in which elbow joints were mobilized with free fascia transplants, with good functional results.

Neff (122) reported a case in which he interposed a pedunculated triceps aponeurosis flap between the humerus and ulna and the radius and ulna. Seven months after the operation, there was active painless motion of 180 degrees

and 30 degrees, and only slight lateral mobility. The joints of the wrist and hand, which were previously partially ankylosed, regained from one-third to one-half their normal range of mobility, with the return of function to the elbow.

Delbert (49), in 1912, reported having done nine resections of the elbow with articular grafts. Most of these were too recent to determine the results, but he reported in detail two cases of a year's duration in which the results appeared to be permanent. In one of these, he used cartilage from an ankle joint; in the other, cartilage from an elbow. Both gave good functional results.

Chaput (32, a) reported three cases in which he resected from the thigh a flap of fat the size of the palm, and encapsulated the lower end of the humerus with it, suturing it to the neighboring muscles by anteroposterior and lateral sutures.

Conrad (37), in 1912, published a dissertation on the use of muscle flaps as interposing material. I have been unable to obtain a copy of this thesis.

Pomponi (141) advocated the use of a pedunculated fascial flap by the method of Durante. He cited one case in which he gained complete pronation and supination, nearly normal extension, and flexion to 60 degrees.

Murphy (120, b) reported twelve arthroplasties on the elbow, using pedunculated fat and fascia flap.

Mauclaire (112) mobilized an elbow, using cartilage from the astragalus to cover the defects. One fragment was put on the lower end of the humerus and another between the radius and ulna. A roentgenogram later showed these grafts fused to the bone.

Putti (145, a), in 1913, reported his arthroplasties to date. These included twelve elbow cases in which he used Kocher's incision and a free flap of fascia lata. He obtained stable joints, with a useful degree of motion.

Roepke (156) reported ten cases of ankylosis of the elbow in which he did arthroplasties, using free fat flaps to interpose between the joints. He advised against beginning passive motion too soon. One case of arthritis deformans was shown in 1911 before the Medical Society of Jena. In others, the ankylosis had resulted from trauma, neisserian infection, and tuberculosis.

Exner (62) reported a case 14 months after an arthroplasty in which a free flap of fascia lata was interposed. The arm was somewhat unstable, but gave good function. The patient could lift heavy weights. At the same time Pupovac reported a second case by the same method.

Darling (43) reported an arthroplasty with the use of a pedunculated flap done in the presence of active infection. The immediate result was good.

Harris (79), in 1914, reported two elbow cases by the Murphy method. In one he gained 75 degrees motion. In the other there was 60 degrees motion.

Turner (184) reported an arthroplasty of the elbow for an ankylosis following a severe osteomyelitis. There had been a musculospiral paralysis from which the patient made a perfect recovery. The elbow had entirely healed, but, at the time of operation, a small area of latent infection was found. Turner used a posterior skin incision and inserted a flap of fascia lata. The elbow was put up in extension. The next day there was a recurrence of the paralysis with signs of local infection. Later, fearing re-ankylosis, he manipulated the elbow under ether into extreme flexion. Six months later, the boy had motion from 50 degrees to 120 degrees, and a useful arm, though the muscles were still atrophied.

Murphy (120, c), in the same year, cited two cases operated on by his usual method. One patient left the hospital in 5 weeks, with free flexion and extension within an arc of about 45 degrees. The other patient, one year after the operation, had motion to 120 degrees.

Vulpius (188) prefers pedunculated flaps, but also uses free flaps of fat, or fascia and fat, or Baer's membrane.

Durante (58), in 1914, interposed a flap of the sturdy aponeurosis taken from the forearm. This method is indicated particularly in extended and hyperextended ankylosis and in cases at a right angle.

Simon (171), in 1914, in operating for ankylosis in a position of extension of about 170 degrees, used a longitudinal incision and a

pedunculated flap from the fascia of the upper arm. The result was the ability to bend the elbow almost to a right angle and to extend it at least to 170 degrees.

Payr (134, a) emphasizes the importance of removing the capsule, or at least the synovia as well as the fibrous cartilage. He has met with secondary dislocations and loose joints only in some of his first knee cases. The initial gain in motion is preserved, or even increased, with use. He had trouble with persistent swelling, especially in cases where this had existed for a considerable time before operation, or had been marked. He believes convalescence is shortened by waiting until the swelling has subsided. If re-operation is needed, he advises waiting at least 6 months. In 1914, his first case was 4 years old. He reports twenty-two arthroplasties, of which three were elbows, one with a good result and two with very good results. He believes that, if the indications are correct and the technique and after-treatment good, a favorable result is to be expected in 70 to 80 per cent of the operations.

Pupovac (144) reported a case of a girl of nineteen whose elbow had become ankylosed at 130 degrees as the result of a severe arthritis. He did an arthroplasty, using a posterior incision and a free fascial flap, and gained motion from 105 degrees to 140 degrees. Five months later, he reopened the joint and removed some exuberant bone that united the humerus with the ulna. He gained 70 degrees to 130 degrees motion.

Davis (46) thinks that we should be conservative about opening a joint ankylosed by tuberculosis. He finds the elbow one of the most satisfactory joints for an arthroplasty, as well as for an excision, but the results with the former are much more satisfactory. An excision requires the removal of 1 to 1.5 inches of bone to ensure movement, but, with an arthroplasty, only sufficient bone need be removed to interpose the flap, and it is almost certain to give a stable joint. He used two pedunculated flaps, one from either side. The joint, he believes, should have drainage.

Murphy (120, a) reported in 1915 a case of ankylosis following fracture. The elbow was ankylosed at about 150 degrees with a few degrees of motion. Seven weeks after operation, there was good pronation and supination, and perfect freedom of motion.

Ashhurst (7) uses an incision along the external supracondylar line and the external condyle, detached from the humerus with an osteotome. A pedunculated flap is inserted, and the external condyle replaced by means of a Lambotte self-boring screw. He reports five cases. In these cases there were three good end-results. One case had a flail joint with very slight power of extension. The fifth case had a limited motion, but the patient refused forcible manipulation.

Gilbert (68) cited a case of dislocation of the elbow which had existed 3 months. Good use of the joint was obtained after a Murphy arthroplasty.

Tubby (182, a) reported one elbow case in which he used a muscle flap. At the time of the arthroplasty, insufficient bone was removed and re-ankylosis took place. Eight months later, he did a secondary operation to remove the mass of new bone. After this intervention, all movements were free, but the elbow was slightly flail.

Chaput (32, b) reported a case of arthroplasty for ankylosis following luxation of the elbow. He used two lateral pedunculated flaps and sewed the skin up tight. The arm was put up in a sterile dressing in extension. The following day the arm was flexed, and flexion was complete and vigorous. He attributes the good result to sewing up the wound without drainage and to the immediate mobilization.

Graff (73) described a case in which he interposed a flap of triceps muscle with almost complete return of normal motion.

Kennedy (98) cited a case in which a pedunculated flap was used. The end-result is not reported.

Murphy (120, d) reported a case showing perfect motion 7 months after arthroplasty for ankylosis from a fracture. A second ankylosis from tuberculosis showed a good end-result.

Whitman (193) exhibited before the New York Surgical Society a case in which an arthroplasty had been done for a fibrous ankylosis following tuberculosis. Four years before, an arthroplasty had been done using a

pedunculated flap. At the second operation, the fibrous ankylosis was found to have become bony. Whitman used a flap of fascia lata at this operation. He believes that, in an ankylosis following tuberculosis, a free fascial transplant is essential to success, as the tissues about the joint are atrophied. His case showed a perfect end-result, with normal flexion and 165 degrees of extension.

Brown (22) gained 80 to 150 degrees of motion in an arthroplasty by the Murphy method. The arm had been ankylosed in extension following acute metastatic arthritis.

Rovsing (159) reported before the Northern Surgical Society two successful cases in which the Murphy method was used. The ankylosis was the result of fracture. In the discussion, Bergman and Haglund expressed the opinion that mobilization of the knee should not be attempted.

Moszkowicz (119), in his report in 1916 on his operation on war injuries to joints, gives among other cases six elbow arthroplasties. In all of these a useful degree of motion was gained.

Ringel (151), in 1916, mobilized five cases of complete ankylosis of the elbow and implanted fat and fascia flaps. One good result was obtained; three cases were being treated when he reported, and in the other case suppuration developed.

Four cases of mobilization of the elbow, in which flaps of fat were interposed, were reported by Werde (190), in 1916. He obtained normal motion in all cases.

Steindler (174), in 1916, reported two operations. In one of ankylosis of the humerus, a pedunculated muscle flap was used. Mobility was good as long as the patient was under observation. The end-result is not reported. The other case followed fracture of the head of the radius, resulting in partial ankylosis. A pedunculated fascia flap was inserted. In two weeks range of motion was about normal.

Crosti (41), in 1916, presented a case in which he had interposed an aponeurosis flap taken posteriorly from the forearm. Complete bony union at an angle of 130 degrees was a result of fracture from a shell. There was a vast amount of cicatrix. The olecranon was temporarily detached according to Durante's process. To ensure pronation and supination, he interposed a small muscular flap between the radius and ulna according to the process of Huguier. The olecranon was nailed in place. Movements were started in 10 days. In 8 months there was complete active extension, flexion at an angle of 40 degrees, good movement, pronation was somewhat fettered, and supination was restored.

Plummer (140) reported two arthroplasties in which he used pedunculated fat and fascia flaps. One of his cases became infected, and subsequently a portion of the end of the humerus had to be removed. The resulting joint was somewhat flail, but gave good function. His second case also had good motion, but facility for moving joint was not good.

Ryerson (160) gives in detail his operative technique in arthroplasty on the elbow joint. He uses a long posterior incision, avoiding the olecranon. The triceps tendon is cut and a thin shell of bone is removed from the external condyle, taking the origin of the extensor with it. Then a shell from the internal condyle is removed. The joint is dislocated. After it is remodeled, a flap of fascia lata is interposed.

Thomson (180) reports the end-results in an elbow arthroplasty by the Murphy method. Ankylosis was the result of sepsis following a fracture. Seven months later, elbow motion was good, but somewhat restricted. His successful cases have all been traumatic. He believes that neisserian infection is a contraindication to arthroplasty, as it stimulates bone formation. Tuberculosis is also a contraindication, on account of the recrudescence of the disease.

A brief mention is made by Prando (142) of a case using a modification of the Murphy method. He did not use an Esmarch bandage, and enveloped the ulnar nerve in a flap of muscle taken from the triceps. He is satisfied with his results. He also reports a case in which Padman followed the Murphy method. Satisfactory motion was obtained, but later the joint re-ankylosed. Prando believes that the Murphy method is very good, although it cannot be so successful as orthopedic resection, on account of the great danger which the slightest negligence involves.

Ceccarelli (31) used strips of fascia lata in an arthroplasty on a post-traumatic ankylosed elbow. The end-result was perfect flexion, extension to 165°, and almost normal pronation and supination.

Olivieri (128) reports two arthroplasties with interposition of strips of brachialis anticus. The end-results were perfect.

Hohmann (89), in 1918, reported five elbow arthroplasties in which he inserted part of the triceps with good immediate results. Lange at the same time showed six cases in which useful joints were obtained and the patients were enabled to resume their old occupations. He used fat or muscle flaps.

Baer (9,a), in 1918, reported having done to date three arthroplasties on the elbow joint. In one, re-ankylosis occurred, one patient died, and the third showed 25 degrees motion. He believes that the elbow is the least favorable joint for arthroplasty, and that the success from the interposition of muscle or fascial flaps is due to the amount of bone removed rather than to the flap itself, and that these operations are in fact only excisions. In the discussion of this paper, Galloway and Freiberg express the opinion that an arthroplasty has no advantage over an excision. Davis states that with an arthroplasty a more stable joint is obtained.

Albee (3) uses a vertical incision directly over the olecranon. After retracting the ulnar nerve and dissecting the soft tissues, he saws through the olecranon from within outward. He remodels the joint and interposes a flap of fascia lata containing as much fatty tissue as possible. The arm is put in plaster at right angles. After 10 days, passive motion is begun.

Henderson (81), in 1918, tabulated the end-results of the forty-three arthroplasties done at the Mayo Clinic. Twenty-one of these were on the elbow. He found the prognosis most favorable in the jaw and next in the elbow. The knee was the most unfavorable position. In reports from other surgeons he found a general agreement as to prognosis.

Kleinschmidt (102), in 1919, demonstrated two cases in which he secured mobility, using Payr's method. One case of complete ankylosis had resulted from a shot wound and the other from acute rheumatism. Good active and passive motion to a sharp angle were secured, extension was complete, and pronation and supination amounted to 60 degrees.

Grange (74), in 1920, used a flap of fat from the posterior surface of the triceps and a piece of cargile membrane on each side of the flap in an arthroplasty for complete ankylosis of the elbow at an angle of 90 degrees. The joint was reached through an incision 4 inches long on the outer and inner side of the joint and a transverse incision across the arm above the olecranon. The ulnar nerve was dissected, the triceps muscle divided, and the humerus exposed. Flexion of 30 degrees beyond a right angle and extension of 45 degrees from a right angle were secured. The pronation and supination amounted to about 30 degrees, due perhaps to too little excision of bone.

Kerr (99) cited a case of complete ankylosis of the elbow following arthritis. He used Kocher's incision and inserted periarticular fascia. The result was a movable, useful joint, with no atrophy of the muscles.

Verral (187), in 1920, described his method of operation. He makes an eight-inch incision along back of the elbow. The triceps tendon is divided in two layers to overlap when sutured. A fascia flap is sutured over the end of the humerus. The elbow is put at about 120 degrees.

Rocher (153), in 1920, applied Putti's technique, using a flap of aponeurosis fascia lata in operating for a case of fibrous ankylosis of the elbow in an almost rectilinear position. He secured a perfect functional result of voluntary flexion to 80 degrees and pronation of 45 degrees.

Silfverskiöld (170), in 1922, reported an arthroplasty, using flap of fascia lata. In eight months the patient showed full active capacity for flexion and extension.

Campbell (26,b) has just published his method for arthroplasty of the elbow, which is evolved from his method for reduction of old dislocations. An incision 6 to 8 inches long is made on the posterior aspect of the arm and forearm. The skin and fascia are incised and the deep fascia dissected laterally about one inch. The suture is then dissected downward, making a long tongue flap.

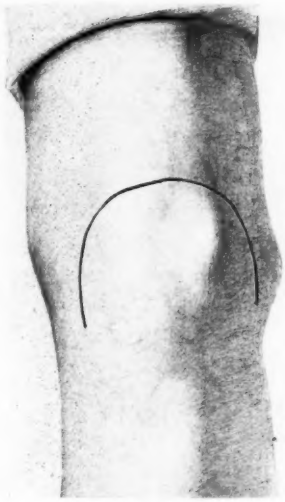


Fig. 1. Line of incision used by the author.

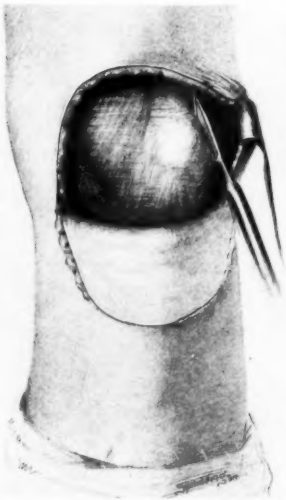


Fig. 2. Dissecting out the ulnar nerve.

Fig. 3. Cutting through the muscle and fascia down to the joint.

Through a further incision the periosteum is stripped from the lower third of the humerus. A half-inch of bone is removed from the humerus and the end modeled into a surface convex from before backward. A half-inch of bone is then removed from the tip of the olecranon process. The surface of the head of the radius is made the same level as the coronoid process. The periosteum and triceps are dissected into a double flap, which is stitched to the anterior capsule. One case of ankylosis as a result of acute infectious arthritis, operated on by the above method, in 6 months resulted in complete extension

Fig. 4. Sawing through olecranon nd end of humerus.

Fig. 5. Splitting off tip of olecranon with chisel.

Fig. 6. Removing with rongeur forceps bit of olecranon tip left in humerus.

Fig. 7. Scooping out ulna and radius with curette.

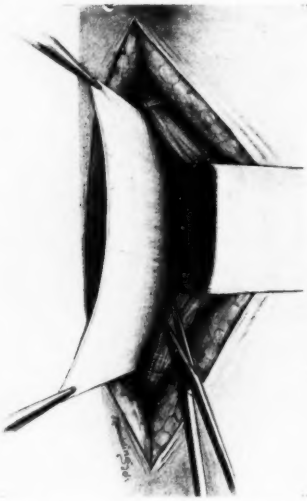


Fig. 8. Cutting fascia lata from thigh.

Fig. 9. Sewing flap of fascia lata to elbow joint anteriorly.

with flexion to 60 degrees. Physiotherapy is being used to increase the flexion.

In case of a normal radio-humeral joint with bony ankylosis between the ulna and humerus, a hemi-arthroplasty is done between the humerus and ulna and a broad aponeurotic tongue flap from the triceps interposed. The one case reported, of solid bony ankylosis, in six months resulted in 50 per cent of the normal motion.

The after-treatment is very important, and active motion is essential.

Operative technique—author's method. The arm from the wrist to the shoulder and the leg on the same side, from the hip to the knee, are given a two-day preparation. At the time of the operation, a tourniquet is applied to the upper third of the arm and an application of iodine made to the skin.

A semicircular incision is then made, beginning over the external condyle (Fig. 1), running down about two inches and up over the internal condyle. The wound is sponged with alcohol and carefully clamped off to avoid handling the skin during the operation. The flap containing skin and superficial fascia is then dissected back to the base line and retracted. The ulnar nerve is isolated and dissected out of its sheath (Fig. 2). It is sometimes difficult to find this nerve, but it is always to be sought at the inner side of the internal condyle. It should be dissected out carefully with a blunt dissector so as not to injure it. After it has been freed for one and one-half inches, gauze is passed beneath the nerve, and it is retracted to the ulnar side. It is then freed further by blunt dissection with gauze.

A transverse incision is then made extending down through the periosteum (Fig. 3). This incision follows in direction the superficial one, and outlines a flap which is to be dissected back and preserved *in toto* for subsequent covering for the joint. The pulling back of this flap is a hard and tedious process until it is well started, after which it can be peeled back readily by blunt dissection. It is the inner side that is the hard part, as the layer is thin here, and one must exercise great care not to buttonhole it. The olecranon is then sawed through (Fig. 4). After this, it is frequently possible to break open the old joint. In some cases, however, ankylosis is bony and the joint cavity obliterated. Cases of this kind are the most difficult. It is in these cases necessary to saw through the joint. The tip of the olecranon has to be chiseled out and dissected back with its posterior flap. Usually

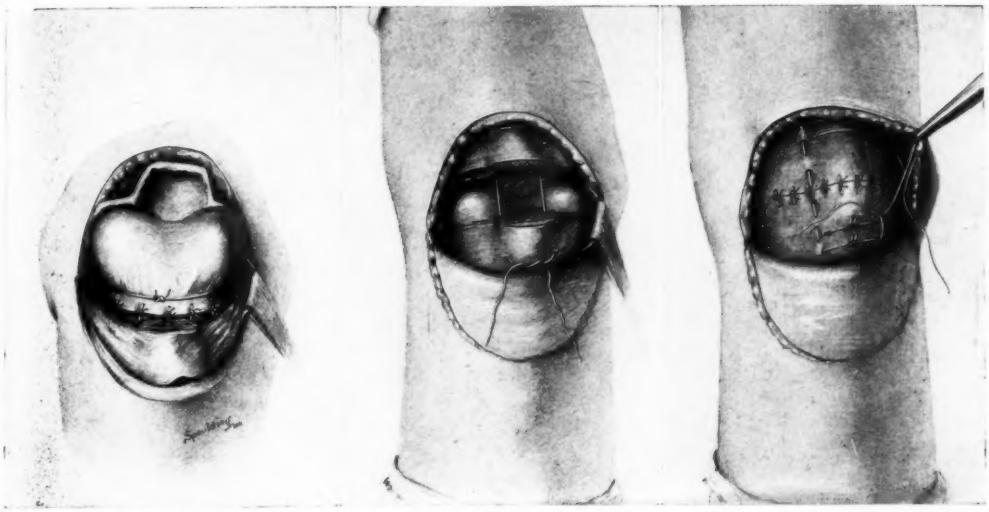


Fig. 10. Fascia sewed over humerus; tied with chromic catgut suture.

Fig. 11. Kangaroo suture through ulna and olecranon tip.

Fig. 12. Stay sutures.

the olecranon is too large, and it is well to take off a little of it (Fig. 5).

The capsule, fascia, and ligaments are then dissected back so as to allow the lower end of the humerus to protrude into the wound. Then its edges are snipped off with rongeur forceps and a new trochlear or intercondylar surface formed (Fig. 6). A shoemaker's rasp is used in filing the extremity as near like the normal humeral end as possible. After this modeling, a piece is removed corresponding to the olecranon fossa in the normal humerus. One has to be careful about making this cup, as the success of the operation depends largely upon attention to such small details (Fig. 7). This modeling is largely done with a saw and a file.

To ensure good function, the joint surfaces should fit accurately before the fascia is applied, but the joint should not be too loose. Only sufficient bone must be removed to give free motion. If too much of the ends of the bones is removed, a flail joint will result, giving the operation no advantage over an excision. When this mortising is completed, the fascial flap is dissected from the leg (Fig. 8). An incision is made on the outer side of the thigh, a little below the middle, extending down to the fascia lata. After a flap of fascia 5 to 7 inches by 4 to 5 inches wide is dissected out, the wound is closed.

This fascia, which is free from all fat, is placed about the newly fashioned humeral condyles and attached anteriorly to the capsule (Fig. 9) and posteriorly to the periosteum of the lower end of the shaft of the humerus with interrupted chromic catgut sutures No. 2 (Fig. 10). Chromic catgut No. 2 is then loosely wound twice around the shaft just below the interrupted suture line.

The forearm is placed in apposition to the condyles. Two drill holes are then made in the olecranon process and two others opposite them in the shaft of the ulna. Through these kangaroo tendon is passed and tied (Fig. 11). The inner layer is now sutured with chromic catgut No. 2 and the skin and fascia with plain catgut No. 2 (Fig. 12). Dry sterile dressings are applied and the arm put up in plaster beyond a right angle.

After-treatment. If there is no evidence of infection, the cast should remain on for a week. It is then split and the dressing changed. If there is a persistent temperature, a window should be cut in the cast and the wound inspected.

Passive motions are begun in about 10 days, if normal healing has taken place. The arm is

Fig. 13. Case 1. E. S. Roentgenogram showing position of ankylosis before arthroplasty.

always kept above a right angle. After 3 weeks, gentle massage is applied. Baking is begun in 6 weeks, three or four times a week.

The ultimate success in these cases depends very largely on the after-treatment. The patients should be under observation for a long period of time. Frequent X-rays should be taken so that we may follow the bony changes in the joint. If motion begins to shut down, the arm should be manipulated under an anæsthetic and the elbow put up in acute flexion. Occasionally motion becomes limited, due to an exuberant growth of new bone. In this case, a secondary operation should be done to remove this, but it should not be undertaken for at least 3 months after the original operation.

Case 1. E. S. was admitted to the Carney Hospital, August 11, 1913, for immobility of the right elbow and right knee. Six years previously, the patient had had an acute illness accompanied by fever and pain and swelling in the joints, for which she was treated in her home, without relief. At the end of 8 months, the pain and swelling had disappeared from her left shoulder and elbow so that she was able to feed herself, but she remained in bed for 12 months and after this was in a wheel-chair

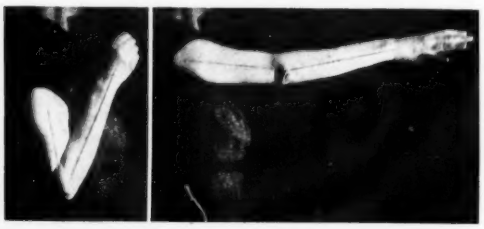


Fig. 14. Case 1. E. S. End-result, 5 years and 10 months after arthroplasty. At left, voluntary flexion; at right, voluntary extension.

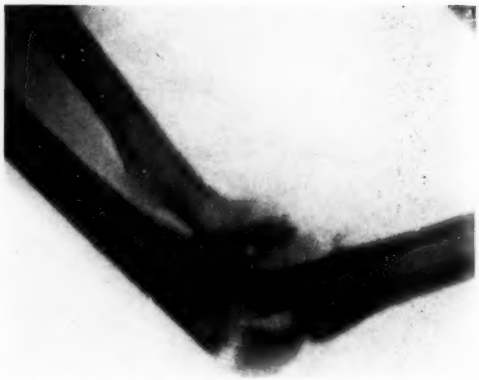


Fig. 15. Case 1. E. S. Lateral roentgenogram, 5 years, 10 months after arthroplasty.

for 2 years. The symptoms continued to subside and the pain and swelling disappeared; fairly good motion returned to all the joints except the right elbow and the right knee, in which pain and stiffness continued at the end of the fourth year, and no motion was possible. This condition continued up to the time of admission.

August 14, 1913, roentgenoscopy revealed an ankylosis of the elbow joint and of the patella to the femur (Fig. 13).

August 20, 1913, I did an arthroplasty of the right elbow using a flap of fascia lata. A light plaster cast was applied. Following the operation, the patient made a good ether recovery. There was slight pain in the elbow.

August 27, 1913, the cast was split for dressing.

September 1, 1913, the wound had healed by first intention except for a slight discharge on the upper border.

September 4, 1913, daily manipulation of the elbow was ordered.

September 10, 1913, the arm could be extended completely and flexed to 15 degrees beyond a right angle.

September 15, 1913, traction was applied for flexing and extending the arm.

October 1, 1913, active motion was possible.

October 15, 1913, I manipulated the arm under ethyl chloride.

May 15, 1919, 5 years and 10 months after operation, she writes: "The arm is doing excellent work." Photographs taken at this time show practically full extension and flexion (Figs. 14 and 15).

Case 2. E. S. sustained a fracture of the right elbow on October 4, 1913, as the result of a fall of 42 feet. The roentgenogram showed a transverse fracture of both condyles with the radial head dislocated laterally and anteriorly.

Physical examination was negative except for the right arm. The shoulder appeared normal. The elbow was held at 150 degrees extension with less

than 3 degrees motion. Supination was limited one-fourth. The wrist showed a Colles fracture unreduced. Flexion and extension were both one-half normal. Eversion was limited three-fourths and inversion four-fifths (Fig. 16).

On March 25, 1914, I did an arthroplasty on the right elbow, using a flap of fascia from the thigh. When the joint cavity was opened, it was found that the synovial tissue was hypertrophied, and there was much fibrous callous formation infiltrating the articular surfaces. A transverse fracture of both condyles was noted. The head of the radius was impacted, and was surrounded by callous formation.

Five-eighths of an inch of the condyles was sawed off square at right angles to the shaft of the humerus. The joint surfaces were smoothed off and the operation completed according to my usual method. The arm was put up in plaster in an extended position. The patient made a good ether recovery, but suffered considerably from pain, for which morphia was ordered, and the following day the arm was put up in suspension. He continued to suffer considerable pain for 4 days, after which it abated.

On March 29, 1914, the wound was dressed, and was found clean except for some serous discharge.

March 30, 1914, the cast was split and a voluminous dressing applied with splints to the forearm.

March 31, 1914, the patient was seen in consultation by Dr. Courtney, who reported a tourniquet paralysis, and advised electricity and massage.

April 1, 1914, the wound was dressed, and found clean and healing by second intention. Electricity and massage daily.

April 5, 1914, the patient was out of bed and walking about the ward. When dressed, the wound was found clean.

April 10, 1914, the wound was dressed. The motion in the elbow was good, with supination and about 45 degrees motion in flexion. A nerve report was ordered.

April 15, 1914, the nerves were reported responding to the faradic current. The prognosis was considered good. Massage was advised.

April 18, 1914, the patient was discharged from the hospital to report daily at my office.

November 30, 1914, the patient re-entered the hospital for operative interference in an attempt to gain increased motion. Both bones of the forearm had dislocated backward and the head of the radius was very much enlarged. Motion was from 150 degrees extension to 50 degrees flexion with the carrying angle markedly increased.

Fig. 16. Case 2. E. S. Roentgenogram showing ankylosis before arthroplasty.

On December 2, 1914, after the usual preparation, a four-inch incision was made over the external condyle. The removal of the enlarged head of the radius caused a marked increase in motion, but the posterior dislocation was not improved. The internal condyle was chiseled loose and removed through a small incision over the fragment. After the end of the humerus was smoothed as much as possible with a rasp, the wound was closed and a cast applied with the arm at right angles. A good ether recovery followed.

After the operation, the patient suffered considerably and showed some swelling of the arm. On the fourth day, the cast was split, and the patient experienced relief.

On the seventh, the patient was comfortable and out of bed. The following day he was discharged, to report to my office.

The end-result shows nearly normal range of motion with a stable, useful joint.

On October 29, 1920, he writes: "I can crank a Ford. I can do anything that I ever could. My work is driving and repairing automobiles, and I have had to change 38–7 tires on the road, which requires the use of two good arms." (Fig. 17.)

Case 3. F. D. In 1910, the right elbow became swollen and tender. At this time an open operation

a. b. c.

Fig. 17. Case 2. E. S. End-result, 6 years, 6 months after arthroplasty. a, voluntary flexion; b, voluntary extension; c, range of motion.

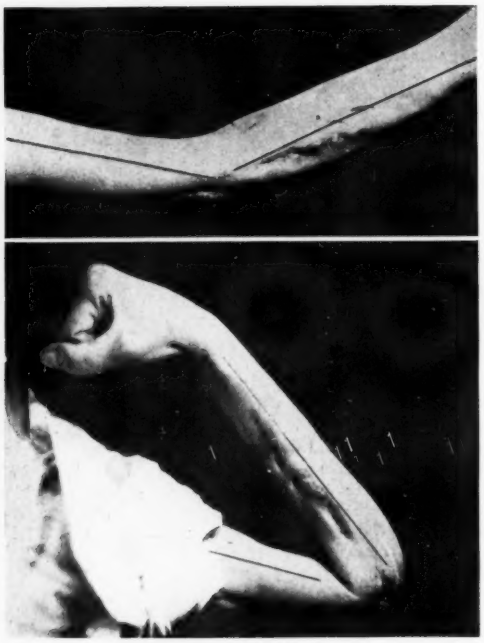


Fig. 18. Case 3. F. D. End-result, 1 year and 4 months after arthroplasty. Below, voluntary flexion; above, voluntary extension.

was done on the joint. Six months later, another operation was done after which the elbow drained for 4 years and the patient lost the entire use of the arm. There were numerous scars above and about the elbow. The elbow was ankylosed at 180 degrees. Finger and shoulder motions were normal.

On August 10, 1918, by the usual method, I did an arthroplasty on his elbow. He made a good recovery and had a normal convalescence. Two weeks later, he was discharged to have daily dressings done by the family doctor. Motion at this time was from 80 degrees to 100 degrees without pain.

He reported at my office on August 30, 1918. At this time the wound was quite healed. The elbow showed 30 degrees motion. He was then seen about every 6 weeks. On October 18, 1918, the wound was found healed. Motion gradually increased.

On December 9, 1919, he showed motion from 35 degrees to 145 degrees, with full supination. The elbow was stable, with no lateral motion. He has no pain, works as a telegraph operator, and "lifts anything." (Figs. 18 and 19.)

CASE 4. E. M. This patient's trouble started slowly with general poor health. Two years ago, she became ill with infectious arthritis, which at first affected the knees. There was no history of a neisserian infection. The patient was very much

Fig. 19. Case 3. F. D. End-result, 1 year and 4 months after arthroplasty. Voluntary extension.

constipated and suffered more or less from tonsillitis. Later, the elbows became painful and could not be straightened out.

Physical examination showed a thickening of the capsule of the left elbow, with about 35 degrees limitation in motion. The left knee showed extension to within 15 degrees of full extension. The patient walked with a marked limp, and flexed knees. General treatment was prescribed, with forcible extension of the knees. As motion in the arm had shut down leaving it ankylosed at 100 degrees, an arthroplasty on this joint was advised.

February 25, 1913, I did an arthroplasty, using my fascia lata method.

March 24, 1913, the arm showed no swelling. There was little pain and the patient's general condition was fair. There was about 15 degrees motion. Gentle manipulation was ordered.

December 16, 1913, the wound had healed by first intention; supination was three-quarters normal, extension was to 170 degrees and flexion to 10 degrees to 15 degrees beyond a right angle. The patient could reach the opposite shoulder with the thumb with ease, but could not dress the lower part of the hair. The muscular power was as good as in the right arm. To gain more motion, a forcible manipulation was advised.

December 29, 1913, under ether, extension to within 5 degrees of straight was obtained and flexion to 45 degrees.

January 26, 1914, examination of the arm showed no lateral mobility and no crunching crepitation. Mobility was from 55 degrees to 145 degrees. (Figs. 20 and 21.)

CASE 5. S. S. This patient was first admitted to the Burbank Hospital, Fitchburg, December 5, 1917, with a subacute neisserian infection. Five years previously the right knee had become swollen, and remained so for 3 months. A month later, the right elbow became swollen and painful. The Wassermann test was positive. She remained in the hospital 38 days, receiving general treatment, and was discharged relieved.

She returned to the out-patient department July 1, 1918. The arm was then put up in plaster from wrist to shoulder to remain on 2 months. She was told that her elbow would probably become stiff and would require an arthroplasty later.

On January 9, 1919, the patient was advised to have an arthroplasty done as her elbow had become stiff. Following the operation on February 6, she had an uneventful recovery. The cast was removed in 2 weeks, after which passive motion was begun. She was discharged March 18, 1919 (Figs. 22 and 23).

Case 6. M. R. For 13 years this patient had had attacks of rheumatism affecting the ankles, elbows, and knees. The physical examination was negative except for the joints. Both knees were slightly flexed and the right one was ankylosed, showing scars on either side. The right ankle showed some contraction of the tendo-achillis. The left elbow showed good motion except for 10 degrees limitation in extension; the right was ankylosed at 125 degrees.

The patient was admitted to the orthopedic service of the Carney Hospital, September 6, 1910, where very slight improvement took place in the knees and feet under conservative treatment. In October, 1910, on account of the swelling and boggi-ness of the left knee, an arthrotomy was advised. This was done October 19, 1910. Daily manipulations were begun on the fifth day, and an uneventful recovery took place as regards the knee.

As the elbow was stiff and in an ungainly position, operation on this joint was advised. On November 5, 1910, an arthroplasty by the Murphy method was done on this joint.

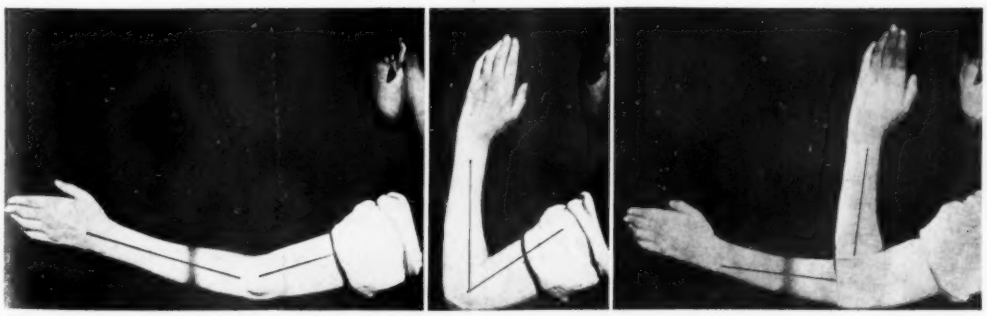
November 10, 1910, the right hand was consider-ably swollen and painful, for which pressure and hot fomentations were applied. The skin on the upper part of the arm became somewhat necrotic from poor circulation and later sloughed.

November 30, 1910, passive motion was begun and repeated daily. The first attempt at motion was made and 30 degrees attained. Following this, progress was continuous and a gradual gain in motion was made. Later, massage was ordered for the hand, forearm, and shoulder.

Fig. 20. Case 4. E. M. Above, lateral roentgenogram 10 months after arthroplasty; below, anteroposterior roentgenogram.

January 11, 1911, about 30 degrees to 40 degrees of motion in flexion and extension were obtained. The wound showed heavy granulation tissue. A week later she was discharged from the hospital. Dressings were to be done at home.

February 28, 1911, she was readmitted to the hospital for manipulation. Normal motion was ob-tained. Since this time, she has been seen in the out-patient department. There is practically no lateral



a. b. c.

Fig. 21. Case 4. E. M. End-result, 10 months after arthroplasty. a voluntary extension; b, voluntary flexion; range of motion (not in full range).

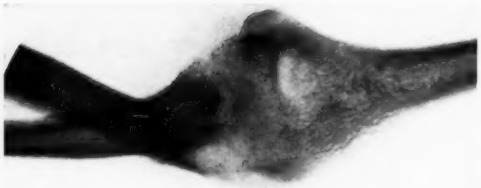


Fig. 22. Case 5. S. S. Roentgenogram showing ankylosis before arthroplasty.

mobility and the end-result is perfect function (Figs. 24 and 25).

For a full report of elbow arthroplasty, the reader is referred to the author's (111) articles appearing in *Clinics of North America*, *Journal of the American Medical Association*, and SURGERY, GYNECOLOGY AND OBSTETRICS.

KNEE

The knee joint presents a greater barrier to good arthroplastic work than any of the other large joints. Lateral stability and security in the knee must be almost absolute. Without stability, a brace is necessary to permit walking; even the use of a brace will not prevent the progress of overgrowth of bone (a direct result of undue strain), with its accompanying pain and soreness. A stiff knee, on the other hand, is a good functional member if the ankylosis is firm and in good position (5 degrees to 8 degrees of flexion). (Figs. 26 and 27.)

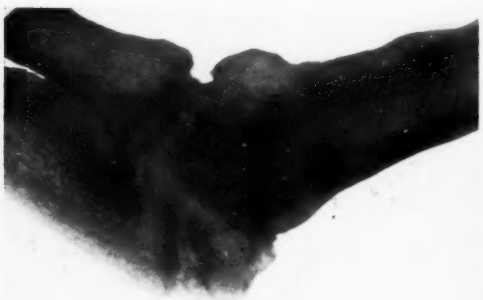


Fig. 24. Case 6. M. R. Roentgenogram showing ankylosis before arthroplasty.

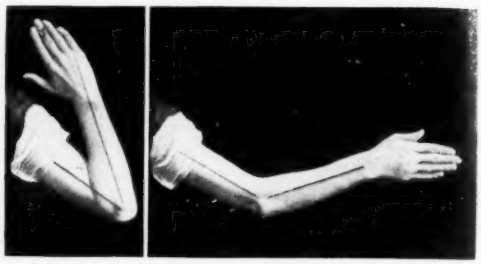


Fig. 23. Case 5. S. S. End-result, 1 year and 4 months after arthroplasty. At left, voluntary flexion; at right, voluntary extension.

If we consider arthroplastic measures in a single ankylosis of the knee, they must be cautiously advised, even in face of the advances that have been made, largely by the splendid work of Professor V. Putti, of Bologna. Arthroplasty must be done with the assurance of stability and freedom from sensitiveness and pain. In other words, we must increase function in order to classify the result as good or improved.

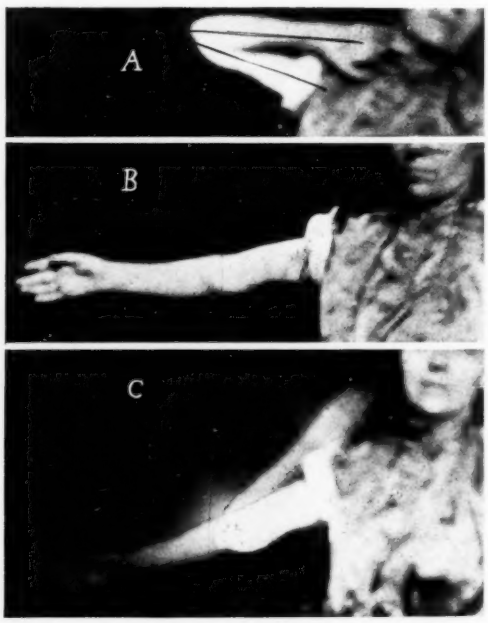


Fig. 25. Case 6. M. R. End-result, 1 year and 3 months after operation. a, voluntary flexion; b, voluntary extension; c, range of motion.

Progress is fast being made, and, although undoubtedly the last 5 years have seen a great advance in the number of functional results, we expect better ones in the future.

Generally speaking, an ankylosis, bony in character, lends itself best to mobilization, as it is more free from the results of tissue infection. Such a condition is true of all joints.

In general, the results of fascia transplantation have proved most successful, and the technique as advised by Putti has given the most consistent results. I differ from his technique only in believing it advisable not to sever or disturb the patella tendon or its attachment.

Operative technique—author's method. The usual preparation is given both legs from the ankle to the groin. I feel it is best to remove the fascia from the opposite leg, thereby minimizing the extent of the operation on the ankylosed leg as well as making it possible to remove more fascia without disturbing the external support of the joint.

The incision is made from just below the inner attachment of the patella tendon, curving slowly over this point to the middle of the external cartilage, and then directly up the outer side of the leg just above the mid-horizontal line, a distance of 5 to 10 inches from the joint proper (Fig. 28). As much fat as possible is taken with this incision. After clamping the skin-edges with towels, the skin is dissected to the inner side of the leg, exposing the patella tendon, patella, and tibial tubercle.

A curved incision is then made through the fascia, beginning in the mid-anterior line, about 5 inches above the patella, and running between the patella and outer condyle to just below the knee joint.

The quadriceps tendon is then exposed and elongated. This elongation not only allows better joint exposure, but affords a proper lengthening when we later place the leg in flexion in plaster. This lengthening may also be done by the Bennett method (Fig. 29). The patella is then raised from the femur, taking the lower cut portion of the quadriceps tendon, and forcibly retracted to the inner side of the knee, with its inner ligament attachments intact. Some surgeons detach a

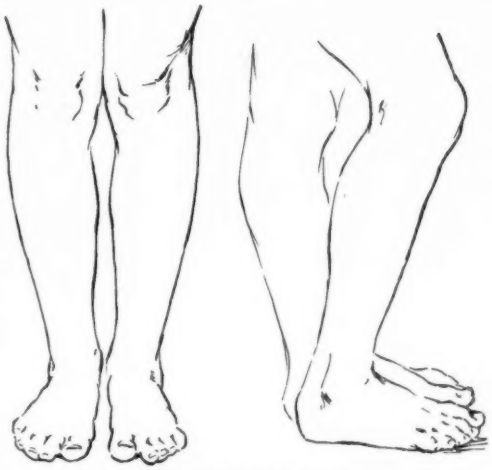


Fig. 26 (at left). Ankylosis of knee, normal position.
Fig. 27. Ankylosis of knee, 30 degrees flexion.

piece of the tibial tubercle in order to increase exposure, but I have found this unnecessary when the quadriceps tendon is elongated in the beginning. There are also many difficulties when this piece is removed, such as delayed or faulty union, which complicate the convalescence (Fig. 31, see frontispiece).

The patella in these cases is often found hypertrophied and should be narrowed laterally, as well as thinned and smoothed with a shoemaker's rasp.

The joint being then exposed, a careful study of it is made from X-rays, and great care is taken to follow the contour carefully. Putti instruments are admirable for this purpose (Fig. 30).

Several important requirements must be observed:

1. Be sure to leave a well-defined spine between the tibia condyle, as well as cup out the upper tibia surface, which will help stabilize lateral mobility (Figs. 32 and 33).

2. Carefully round the condyle with a Putti instrument and a shoemaker's rasp, making a concavity to fit over the newly formed spine.

3. Actually replace these opposing surfaces, and mold carefully, without any irregular hitches during attempts to flex.

4. Cup out a space into which the patella will articulate. Great care should be taken with this modeling.

Fig. 28. Kocher's incision as used in technique employed by author.

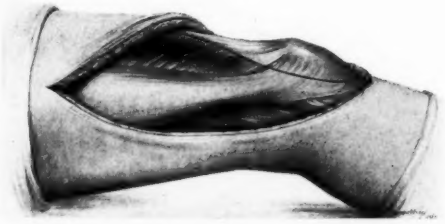


Fig. 29. Incision through fascia and capsule including division of the quadriceps tendon.[1]

5. Remove a large piece of fascia lata ample enough to cover both condyles. The fascia nearest the knee on the outer side is thickest and most serviceable. When this is removed, sew the fascia over the condyle, covering all exposed bone well. Sew posteriorly 2 inches above the articular surface (Figs. 34 and 35). The femur is then adjusted to the tibia, and the patella is replaced. The outer fascia is united with interrupted chromic catgut.

The elongated quadriceps is then strongly sutured and the skin closed with interrupted catgut (Fig. 36). A plaster is applied from the toe to the groin with the knee in 35 degrees to 40 degrees flexion and the leg placed in an elevated position in bed. Opiates are often necessary and may be freely used.

After-treatment. The temperature, pulse, and pain are carefully watched for any signs of infection.

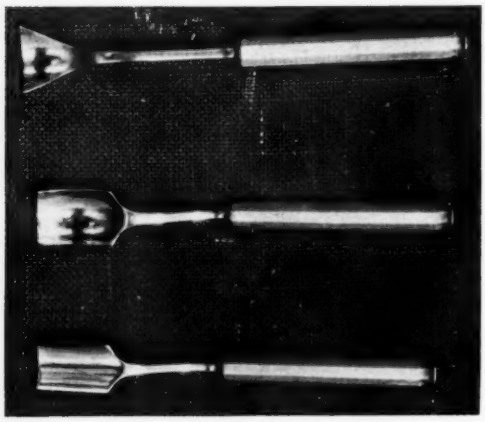


Fig. 30. Putti instruments.

The cast is split for dressing in 2 weeks and the leg put in a ring caliper with 35 degrees flexion, so arranged that this can be changed and passive motion slowly started. Traction is also applied with this caliper which remains on day and night. Gentle passive motions are started and increased gently, guided by pain and sensitiveness, which always should be minimized. Massage is started in 5 to 6 weeks for thigh and calf, and the patient may usually walk with crutches about the sixth week. By means of an overhead extension, the patient may also use passive motions in bed, two or three times a day.

Active motions are started or attempted about the tenth week, preferably with the leg submerged in a tub of water. No actual weight-bearing is allowed until the lateral ligaments have tightened, and a caliper may be applied to assist weight-bearing, depending wholly upon the sensitiveness and pain on use.

CASE 1. F. O. K., age 31. In 1909, patient had an acute neisserian infection in the left knee. The opening of the joint resulted in an ankylosis. The knee was in good position, but there was no motion between the tibia and the femur. The patella was ankylosed to the femur. Manipulations were unsuccessful in obtaining motion. Arthroplasty was advised.

December 14, 1910, arthroplasty on left knee according to the technique as described.

December 23, 1910, out of bed. Daily dressings.

January 5, 1911, cast removed. Posterior shell applied.

January 7, 1911, small amount of weight-bearing. Crutches.

January 19, 1911, patient discharged from hospital. In a leather leglet with limited motion. He is to continue stretching and daily hot fomentations.

January 3, 1923, now 12 years since arthroplasty. Patient has no pain and has had no trouble. "No

[1] Figures 31 to 36, detailing further points in author's technique, shown in frontispiece.

Fig. 37. Case 1. F. O'K. Weight-bearing, 12 years after arthroplasty.

Fig. 38. Case 1. F. O'K. Weight-bearing, 12 years after arthroplasty.

Fig. 39. Case 1. F. O'K. 95 degrees flexion, 12 years after arthroplasty.

bother at all and can do everything. Sometimes has to stop and think which is the knee operated upon." Has gained 40 to 50 pounds. The leg is straight. He has good power in quadriceps. Complete extension is possible and he has 95 degrees motion in flexion. He has absolutely no lateral mobility. (Figs. 37, 38, 39, 40, 41.)

The use of the muscle flap from the vastus internus in operations of the knee joint was suggested by Helferich (80, b). Cramer (40) followed his proposal, and in 1901 reported ten operations of ankylosis of the patella by interposition of a piece of the vastus internus. Six of these were successful. Hoffa (86) reports eight tibiofemoral cases of his own. He used fatty flaps. One case resulted in 15 degrees motion and ability to walk, the second in 15 degrees and painful motion, and the third in good motion, but with slight limping. In three cases ankylosis recurred. The seventh case had good walking ability and the eighth had 15 degrees motion 7 months after the operation. One patella case had 10 degrees motion 2 years after the operation. Hoffa believes his results are due to shortening and the contraction and atrophy of the extensor muscles. It is his opinion that the tendon should be lengthened by plastic operation or the tuberosity chiseled and attached higher up.

Murphy (120, a) first used his fascia method in 1901 on the knee joint. A large layer of fascia lata, with a thin layer of muscle attached, was dissected from the outer surface of the vastus externus, with its base below and anterior. A small flap of fascia covering the vastus internus was dissected free and

Fig. 40 (at left). Case 1. F. O'K. Anteroposterior roentgenogram 12 years after arthroplasty.

Fig. 41. Case 1. F. O'K. Lateral roentgenogram 12 years after arthroplasty.

Fig. 42. Line of Kocher's incision. The dotted line shows the prolongation of the incision which is necessary to obtain the flap for transplant. (Putti.)

Fig. 43. Detachment of the tibial tubercle and the arthrolysis. (Putti.)

Fig. 44. Luxation of the joint surfaces. (Putti.)

placed between the patella and the femur. Between 1912 and 1916, Murphy reported fourteen operations. While at first he used fascia lata from vastus externus, he later used two implants of fat and fascia, one lifted from the inner and one from the outer aspect of the knee. He also changed his incision from two vertical cuts to a U-incision. The patella was treated in four different ways; by placing a flap under it, by turning it turtle, by rotating,

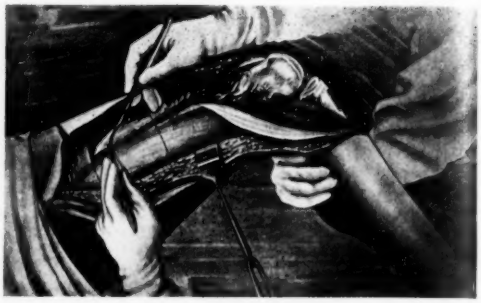


Fig. 45. Preparation of fascia lata flap. (Putti.)

Fig. 46. Attachment of the flap on the resectioned surfaces. (Putti.)

or by transplanting a detached flap of the trochanter. Of the fourteen cases, there were two splendid results, six good weight-bearing legs, one showed good flexion and extension improving, and three records are incomplete. In one, a sheet of paraffin was inserted beneath the patella.

Since 1901 many attempts to mobilize the knee, using Baer's membrane, Cargile membrane, free and pedunculated flaps of fascia, have been reported.

McCurdy (113) and Osgood (131) used Baer's membrane. The former did not report on his result, but Osgood found that, although

good or fair motion resulted, there was some lateral motion. These results, I feel, clearly show the loss of stability so dangerous to function, and do not represent arthroplastic, but rather flail joints.

Tubby (182, a) in 1914 interposed Cargile membrane in three cases with one good result. In the other cases the patients refused the after-treatment.

Schmerz (164) has had good results in the interposition of amnion membrane which he claims surpasses the fascia transplantation in simplicity and safety.

Whitacre (192), Neff (122), Owen (132), Quigley (147), Tubby (182, a), Pringle (143), McKenna (115), Thomson (180), Wheeler (191), Hohlbaum (88), Zeller (199), and Finochietto (64) have used pedunculated flaps of fascia. In general, good serviceable knees were secured; in two cases there occurred lateral motion and one case re-ankylosed. Of eighty-five cases on which Hohlbaum (88) reported, using free and pedunculated flaps, there were 78 per cent good results and 22 per cent poor.

Steindler (174), Thomson (180), Brandstrup (21), Hessert (85), and Goddu (71) reported the use of free fascia flaps with good results.

Whitacre (192), Appel (6), Ogilvy (127), and Hoerhammer (92) secured good motion by the interposition of fascia and fat flaps.

Fig. 47. Before mobilization. (Putti.)

Kirschner (100) and Osgood (131) followed Payr's method, using free fascia flaps, but in Kirschner's cases adhesions formed, and Osgood's result was only fair and necessitated the wearing of a splint. Simon (171) and Schloffer (163), however, secured good results by the same process. Tavernier (176) and Leriche (109) followed Putti's method. The former secured good motion, but Leriche's result was an unserviceable leg.

Flaps of tissue were tried by Hoke and Andrews (91) without success. Hofmann

Fig. 48.

Fig. 49.

Fig. 48. After mobilization, showing weight bearing. (Putti.)

Fig. 49. After mobilization, showing active extension. (Putti.)

Fig. 50.

Fig. 51.

Fig. 50. After mobilization, showing weight bearing. (Putti.)

Fig. 51. Eighty-five degrees flexion. (Putti.)

Fig. 52. Anteroposterior roentgenogram taken 27 months after intervention. (Putti.)

Fig. 53. Lateral roentgenogram taken 27 months after intervention. (Putti.)

(87, b), by the use of free periosteal flaps, obtained only an active motion of 15 degrees. Fascia lata and strips of subcutaneous tissue were used by Verral (187). Roeren (157) secured immediate good results with the interposition of flaps of fat, but the development of lateral motion made necessary the application of an apparatus. Cotton (39) secured a good result by the interposition of a muscle flap.

Campbell (26, a) based his report on twenty-four knee-joint cases. In ten cases using fascia flap, one resulted in 40 degrees motion, one in 30 degrees, six re-ankylosed, and on one there has not been time to report. He used Baer's membrane in nine cases; in one he obtained practically perfect motion; in one, 70 degrees of free motion; in four, the membrane extruded, and in two, of osteomyelitis, good results could not be expected. Two cases, in which free fascia from the thigh was inserted, were failures. In three operations in which prepatellar bursæ were inserted, one resulted in 15 degrees flexion and voluntary extension, the second in 20 degrees flexion and voluntary extension; it was too early to report on the third case. Of twenty of the cases on which there has been sufficient time to record the end-results, thirteen had definite voluntary motion, four did not obtain motion of sufficient value, and three were not successful, as dense bone was involved.

Campbell does not consider his work on the whole satisfactory. He recommends operations for ankylosis of complete destruction of the articular surfaces and adjoining bone, and solid union of bony surfaces. In cases of complete fibrous ankylosis, irregular scattered bands, or irregular fibrous union with areas of destruction, operation is also advised.

Up to 1917, Baer (9, b) had reported twenty-eight cases of arthroplasties on knee joints. He obtained serviceable motion only in cases of fibrous ankylosis between femur and patella or femur and tibia, of which there were seven cases; four gave 75 degrees, 40 degrees, 50 degrees, and 55 degrees of motion, respectively, and good function; three were failures—active tuberculosis set up. In five cases of bony ankylosis between patella and femur and fibrous ankylosis between tibiofemoral joint, excellent results were obtained. In sixteen cases of bony ankylosis between the patella and femur and femur and tibia, 19 per cent secured motion, 7 per cent had no ultimate motion, 6 per cent had 20 degrees, 2 per cent had 30 degrees, and 1 per cent, 45 degrees.

In his early cases Baer made two lateral incisions, one on each side of the patella,

chiseled the bones apart, and modeled the ends of joint surfaces. The first piece of membrane was carried through the opening on one side of the patella to the other side. The second piece overlapped the first; the joint was covered as far as the top of the subquadriceps bursa. Baer later used the horseshoe incision.

The writer believes that the general opinion is that lateral incisions do not give sufficient exposure to model the femur and tibia properly.

In 1920, Putti (145, f) reported on ten cases of knee arthroplasty. The largest range of motion obtained was 100 degrees, the smallest 50 degrees, and the average 82 degrees. The average age was 22 years. Putti thinks arthroplasty of the knee should be executed more frequently, and that the restoration of the knee joint can give the greatest satisfaction to the patient. There is more than an æsthetic value obtained by these operations.

Fig. 54 (at left). Ankylosis of the hip. Note flexion adduction, and inward rotation usually found in this condition untreated.

Fig. 55. Ankylosis of the hip. Note proper position, *i.e.* abduction 10 degrees—slight flexion (10 degrees) and slight external rotation.

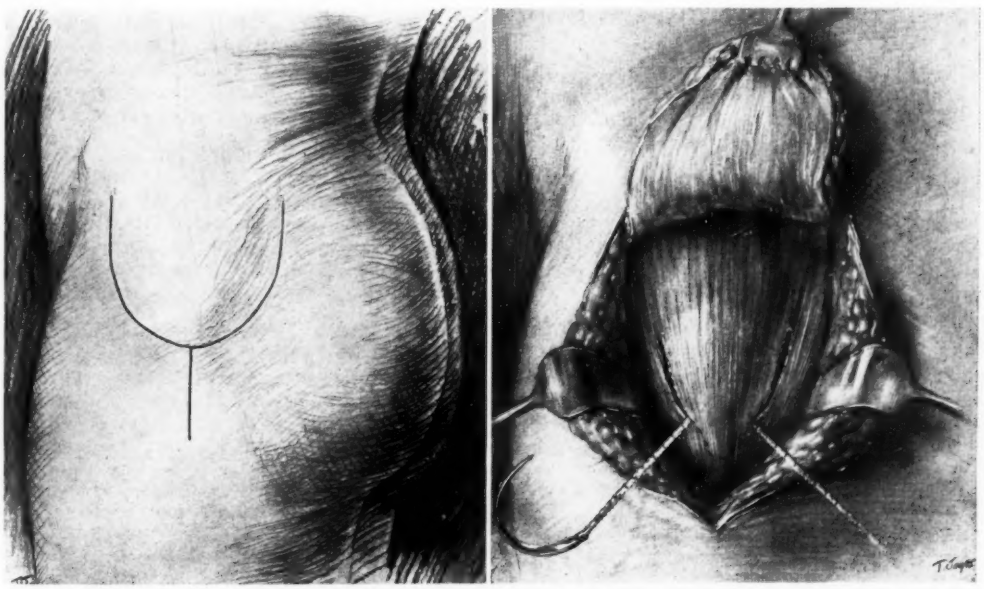


Fig. 56. "Goblet" incision through the skin and fascia lata down to the muscles and trochanter. The lower tip of the upper flap is placed just below the trochanter. The downward prolongation lies along the outer surface of the femur. (Murphy.)

Fig. 57. The flap of skin, fat, or fascia lata has been retracted upward; anterior and posterior borders of wound are retracted, exposing great trochanter with its attached muscles. The chain saw is passed on needle underneath superior muscle group, chiefly gluteus medius, down to capsule of joint, and trochanter with muscles attached is being sawed off in direction indicated by the dotted line. (Murphy.)

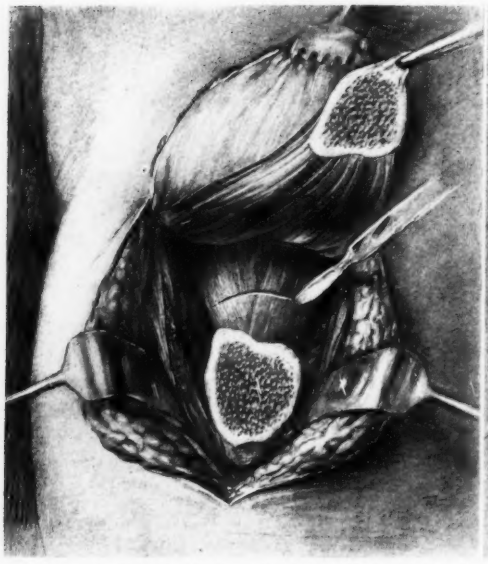


Fig. 58. The trochanter with its attached muscles is drawn upward, the anterior fibers of the gluteus medius muscle having been cut. The capsule of the joint is being incised at right angles to the direction of its fibers. In this operation it was not necessary to cut either the pyriformis or abdurator externus muscles. (Murphy.)

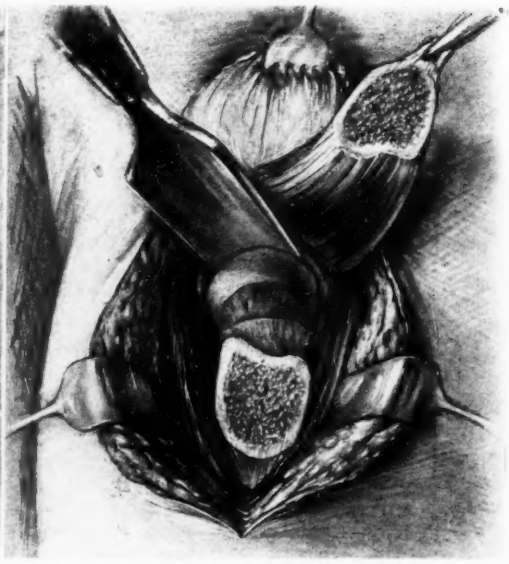


Fig. 59. The large gouge is being driven between the head of the femur and the acetabulum to divide the bony ankylosis between the two. A gouge has been selected the curve of which fits the normal curve of the head of the femur and the acetabulum, so that minimum amount of reshaping is necessary after division of ankylosis. (Murphy.)

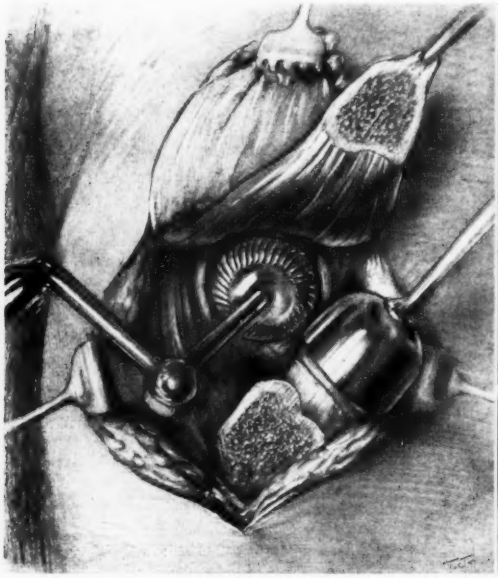


Fig. 60. Reshaping and smoothing the head of the femur and the acetabular cavity with Murphy's end-mill and reamers. Head of the femur is dislocated backward from acetabulum preceding this step. (Murphy.)

Fig. 61. Preparation from under surface of the skin-flap of the Murphy pedicled fascia and fat flap for interposition between the freshened ends of the bones. The dotted lines indicate the extent of the flap. (Murphy.)

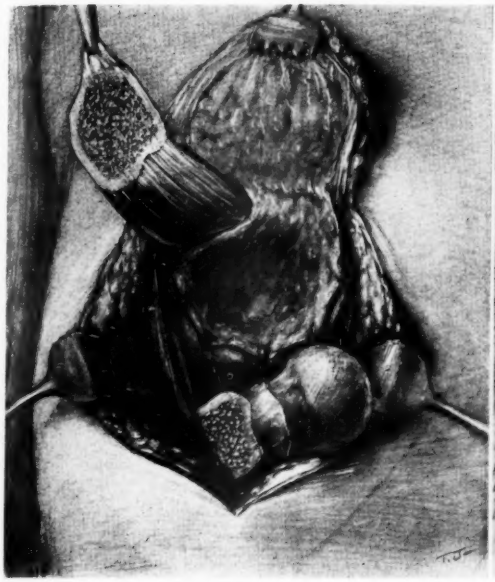


Fig. 62. The interposing pedicled flap of fascia and fat has been passed around the gluteus medius muscle posterior to its attachment, and dropped down over the acetabulum, to the rim of which it has been sutured with chromicized catgut. The head of the femur, when replaced, will lie on this flap. (Murphy.)

Fig. 63. The trochanter has been nailed back in place and the cut end of the muscles sutured. Usually Murphy used a continuous suture of phosphor bronze wire to reunite the muscles. The skin is sutured with horsehair and two or three sutures of silkworm-gut are inserted, if necessary. (Murphy.)

Putti uses the method set forth by Ollier of resecting the articulating surfaces, interposing membrane (Figs. 45 and 46), and preserving all the periarticular structures, particularly ligamentous. A modification of the Kocher incision is used; the cut is prolonged below to round the tibial tubercle (Fig. 42). This allows rolling in the skin after the insertion of the patellar tendon has been removed with the tibial tubercle. A piece of bone 4 by 3 centimeters and 1 centimeter deep is removed (Fig. 43). Solid union of this afterward is very important. As there is sometimes difficulty in making this union, this constitutes the weak point of Kocher's incision. Putti also uses the procedure of plastic elongation by an incision in a Z-form of the quadriceps tendon to overcome strong contraction of the extensor apparatus. This incision gives good access to joint surfaces.

The joint exposed (Fig. 44), the femur and tibia ends are shaped, the spine of the tibia made sharp, and the intercondyloid groove deepened. The transverse diameter of the condyles is preserved, but the sagittal diameter is decreased. In this way the loss of the crucial ligaments is compensated. The ankylosis is freed by a chisel to the posterior side. He uses manipulation to break up the bony lamellæ, smooths resected surfaces by files, and removes any cicatricial mass. He advises against using patella flaps, as he found the patella nearly always increases in thickness. The patella should never be completely removed. The ligamentum patellæ and tibial tubercle are nailed in place by a double-headed nail which is usually removed in a month. If necessary for flexion the quadriceps tendon is lengthened by the "Z" method.

For 15 days the whole leg is in a plaster gutter splint in semi-flexion; 4 to 5 kilograms traction is applied. After the removal of the stitches, the knee is suspended to an overhead frame with strap and pulley. The amount of exercise depends on the patient's strength, ability to stand pain, and the reaction of the

Fig. 64. Complete bony ankylosis of left hip with rotation of leg inward and abduction beyond pelvic inlet. (Murphy.)

joint. With the patient on the edge of the bed, the limb hangs out and flexion is obtained by gravity. In a month, massage, faradism, heat, and mechanotherapy (Bonnet's apparatus) are used. Auto-immobilization is essential. In 6 weeks a stiff leg brace is applied. The patient should have good use of the limb in 3 months.

Among his cases, Putti (145, d) reported one of complete bony ankylosis of the knee at an angle of 140 degrees. Suppurative arthritis had caused wounds to be open 5 months, and resulted in deep cicatrix. There was bony ankylosis between the femur and the tibia and between the femur and patella, and periarticular ossification (Fig. 47). Putti used his regular technique in operation, prolonging Kocher's incision at the base to encircle the tibial protuberance. One month after the operation there was 40 degrees motion, no pain, and complete extension. In 5 months the patient could walk long distances, had complete extension, and flexion to 110 degrees. There was slight lateral movement. In 7 months the flexion was 85 degrees and there was more lateral movement. The leg was serviceable. Fourteen months after the operation the patient returned to the hospital because of severe pain in the knee. The joint was flexed in the position of semiflexion and could not be extended. After traction and hot air applications, the joint improved. The patient walked again, and 27 months after the first intervention he could flex his knee to an angle of 85 degrees, had a movable patella, and *no* lateral mobility (Figs. 49, 50, 51, 52, and 53).

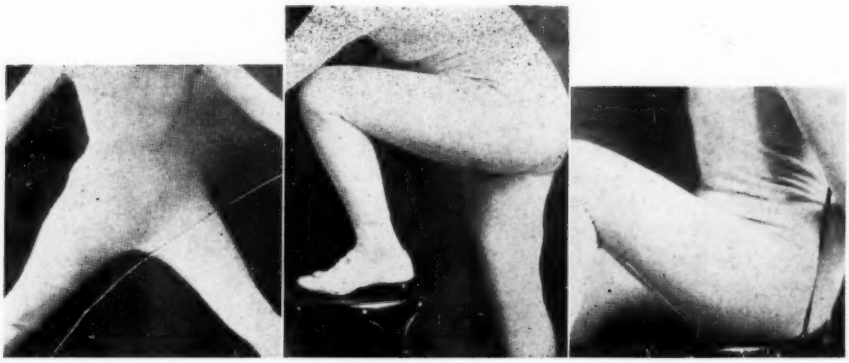
HIP

Ankylosis of the hip practically always is seen in the position of deformity; that is, flexion and adduction (Fig. 54). The correction of this deformity results in a functional limb for working use (Fig. 55). It has, however, a distinct disadvantage in sitting, stooping, going up and down stairs, etc., as well as somewhat interfering with the gait. As the joint is rotary, it lends itself to arthroplastic measures. In single ankylosis, interference is decided upon with caution and judgment. In double ankylosis, the decision is easier.

Any increase in motion in this joint improves the knee-joint action, and this, together with the hypermobility of the lumbar spine, distinctly increases function. One must, however, remember that stability is very necessary, and unfortunate results, such as dislocation, have followed arthroplasty of the hip where stability has not been obtained.

Hoffa's (86) statistics in 1906 recorded three operations on the hip by Rochet and two by Nélaton, using muscle interposition. One of the five cases showed a mobility of 40 degrees in 1 year, the other a good function of 45 degrees in 8 months. One case had good mobility at first, but it diminished later. The fourth case had good motion 5 years after the operation, and the fifth case resulted in poor function 9 months after intervention.

Hoffa (86) reported one of his own cases in which he used a flap of fatty tissue. Seven-



Figs. 65, 66, and 67. One year after operation, showing that patient has a full normal range of motion. (Murphy.)

teen months after the operation the patient walked, but active mobility was somewhat restricted.

Stein (173), in 1907, in Bier's clinic, interposed a flap of the sartorius muscle in a case of double ankylosis of the hip. In 5 months there was 30 per cent of normal flexion, and extension and abduction of 10 per cent of normal.

Ahrens (1), in 1908, used the gluteus maximus muscle. The patient walked in eleven weeks.

Meyer (117), in 1909, cited a case of using a flap of fatty tissue with a thin layer of muscle on a hip ankylosed from spondylitis. The thigh was flexed on the pelvis at 150 degrees. After the operation the patient had passive motion to 60 degrees, extension to normal, adduction 30 degrees, and abduction 45 degrees.

Durán (57), in 1910, used membrane, and he was able to obtain motion of 50 per cent of normal.

Murphy (120, b) found that the hip joint gave him the best results in arthroplasty. He used three incisions; the original one was U-shaped, beginning 1.5 inches above the trochanter and 1 inch behind it, extending down 2 inches below and passing under and in front of it up to a point opposite the commencement. Sometimes the skin was divided down at the lowest point of the U to form the large interposed flap. The second incision was along the iliotrochanter line 1 inch below and in front of the trochanter and upward for about 5 inches in a straight line with the anterior superior spine of the ilium. The third was a modification of the second, in that the incision was curved and convexed backward behind the trochanter (Fig. 56).

His next step was to free the trochanter by a chain saw and retract it upward with attached muscles (Figs. 57 and 58).

The ankylosed head of the femur was severed from the ilium, as near the anatomical line as possible, with a carpenter's and cabinet curved chisel (Fig. 59). It was drawn obliquely into the acetabular cavity for 1 inch. The head was fractured out and a special globular burr fashioned the acetabular cavity. A cup-shaped well conformed the femoral head (Fig. 60).

A flap of fat and fascia, fascia lata, and subcutaneous fatty tissue (one-fourth inch thick) was inserted behind the head and neck of the femur, and the edge was sutured to the acetabular margin and to the capsular ligament with phosphor bronze wire (Figs. 61 and 62). The head was replaced. The trochanter was nailed in place (Fig. 63). The fascia was re-approximated by chromic catgut and the skin sutured with silkworm or horsehair. No drainage was used.

The field operated upon was dusted with bismuth subiodide powder and the wound sealed with gauze saturated with collodion. A pad of plain sterile gauze, moistened with 95 per cent alcohol and 61 per cent phenol, was placed over the hip 4 or 5 inches beyond the line of incision on either side. A Rainey

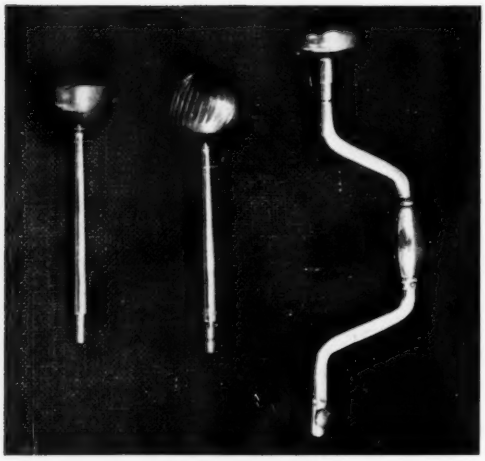


Fig. 68. Murphy instruments.

travois splint and Buck's extension with 20 to 25 pounds were applied. Both legs were dressed in an abducted position.

Passive motion was instituted in 3 or 4 weeks.

In the majority of cases of ankylosis of the hip reported by Murphy, there resulted a good range of motion and ability to walk without support. Among them was one case of metastatic origin, of complete bony ankylosis of the left hip with rotation of the leg inward and adduction beyond the pelvic inlet (Fig. 64). The usual technique was followed in the operation. The patient made an excellent recovery. In 1 year she could walk without support and had full flexion (Figs. 65, 66, 67).

Pettis (138), Torrey (181), Clark (36), Gibby, reported by McCurdy (113), Ceballos (30), Prando (142), Thomson (180), and Burlew (25) reported cases in which they had followed the technique of Murphy, using pedunculated flaps. Several good results were recorded. Thomson believes his case re-ankylosed because he removed too little bone.

McKenna (115) outlined his technique as a modification of the Murphy goblet-shaped incision. The cut was carried farther back to secure a fat and fascia flap that comes directly under the gluteus muscle. This fits into the acetabular cavity without cutting the pedicle of the flap.

Perthes (136), in 1919, mobilized a hip joint ankylosed in the position of adduction. After the freeing of the ankylosis two pedunculated fat and fascia flaps were interposed. In spite of ankylosis of the other hip joint and of the two knees and of paralysis of the sciatic nerve, walking was possible.

Baer (9,b), in 1917, reported his series of fifty cases of bony ankylosis of the hip in which an arthroplasty was done with the use of the chromicized pig's bladder. The resulting motion in nine cases of gonorrhœal arthritis was active motion in 89 per cent. Two cases operated on in 1909 resulted in 20 degrees and 40 degrees motion, respectively. Infection was the cause of failure in one case; in the other, the periarticular tissues needed stretching. In twenty-one cases of tubercular origin, 66 per cent good voluntary motion, utility and good walking ability were secured. One hundred per cent good serviceable motion resulted in fifteen cases of infectious arthritis. In five cases of arthritis deformans involving spine, hip, knees, and ankles, 60 per cent motion was obtained.

Baer makes his incision from the anterior superior spine, down the thigh, parallel to the femur, between the tensor femoris muscle on the outer side and the sartorius on the inner. The capsule is stripped back, the ends of the bones shaped, and the membrane thrown around the femoral head.

Baldwin (10), in 1915, reported a successful result, using Baer's membrane.

Neff (122) used a U-incision with reflexion of the flap upward for the formation of a long, broad flap of fascia lata. If enough capsule was available, it was used for flaps; if not, fascia was interposed.

In 1913, Osgood (131) reported on five cases; in one, using the capsule for a flap, the result was poor; in the second case, using tissue flap, the outcome was fair; in the third case of excision, death resulted; in the fourth case of fibrous ankylosis, in which free fascia was used, the result was good; and in the fifth case of fibrous type, doing a part excision according to Baer's method, the result was fair and improving.

Two methods are used by Payr (134, b) on the hip. One consists of the separating of the

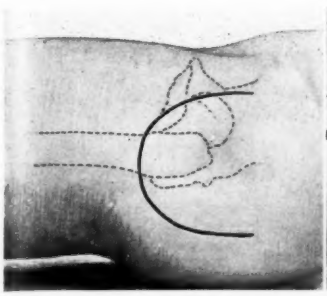


Fig. 69. U-shaped skin incision as used by author.

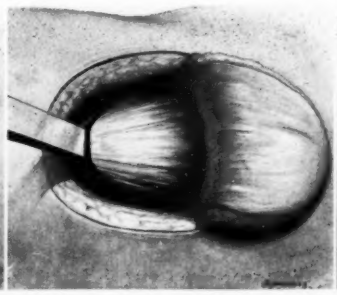


Fig. 70. Line of fascia incision preparatory to removal of great trochanter.

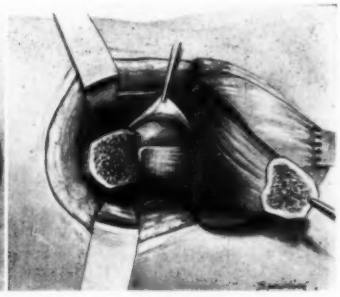


Fig. 71. Incision through capsule parallel to and in center of femoral neck.

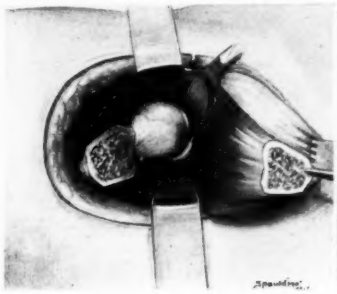


Fig. 72. Separation of the femur from the acetabulum.

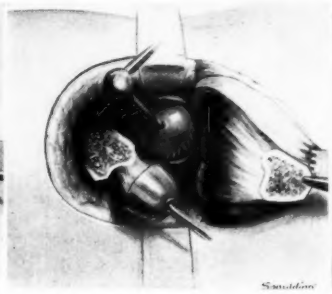


Fig. 73. Reaming out of acetabulum and rounding of head with Murphy male and female rasps.

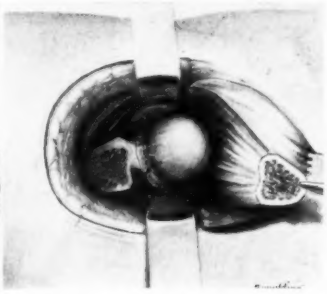


Fig. 74. The fascia flap sewed around neck of femur with interrupted sutures and tied with a purse string.

ankylosis, smoothing off of the head of the bone or building a new rounded epiphysis out of the neck of the femur, with interposition of fat (free or pedunculated) or a flap from the tractus iliotibialis. The second process is the formation of a pseudoarthrosis as near as possible to the acetabular margin, likewise with the interposition of soft parts. Payr tries to form the pseudoarthrosis after the manner of a saddle joint, simulating the carpometacarpal joint.

Corner (38), Steindler (174), and Hallopeau (76) reported the use of fascia lata in the hip. Corner and Steindler did not record their results, but Hallopeau secured a good weight-bearing leg after operation for double bony ankylosis of 4 years' standing.

Grange (74), in 1920, reported three cases of arthroplasty. In one, of bony ankylosis with internal rotation of the thigh, of traumatic origin, a curved incision was made between the crest of the ilium and the great trochanter, the femur was divided at the neck and a flap of gluteus medius sutured over the raw end of the neck of the femur and a loose flap of fat from the buttock placed in the cup in the head of the femur. Within 2 months the patient could flex his hip to a right angle.

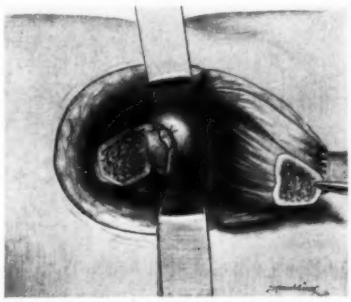


Fig. 75. Reduction of femoral head.

Hohlbaum (88), in 1921, reported twenty cases of hip ankylosis of tubercular, rheumatic,

Fig. 76.

Fig. 77.

Fig. 76. Case 1. O. P. Roentgenogram of right hip before arthroplasty. March, 1916.

Fig. 77. Case 2. O. P. Roentgenogram of left hip before arthroplasty. March, 1916.

Fig. 78.

Fig. 79.

Fig. 78. Case 1. O. P. Roentgenogram of right hip 2 years after arthroplasty.

Fig. 79. Case 2. O. P. Roentgenogram of left hip 1½ years after anthroplasty.

gonorrhœal, arthritic, and other origins. Free fascia and pedunculated flaps were interposed. In his series there were six very good results; five good results; six cases re-ankylosed; two patients died; and in one the result was unknown.

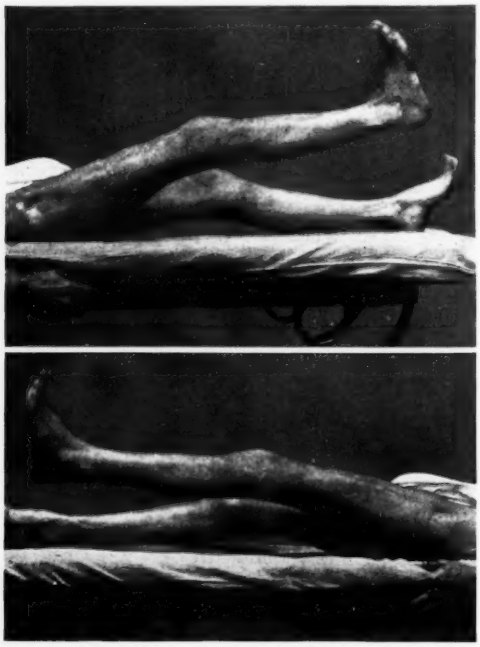


Fig. 80 (above). Case 1. O. P. Motion in right hip 1½ years after arthroplasty.

Fig. 81. Case 2. O. P. Motion in left hip 1½ years after arthroplasty.

Author's technique. In operation on the hip I use the following technique:

The patient is given a very careful two-day preparation of the hip from the rib-line to below the knee.

A skin incision is made beginning at the anterior superior spine and running in a horizontal plane to about 2 inches below the level of the trochanter, at which point it curves over the femur, 3 to 4 inches below the trochanter in a U-shaped fashion (Fig. 69). This flap, with considerable fatty issue attached, is elevated, raised to its base line, and retracted.

A similar incision is made through the fascia external to the sartorius and sweeps around about 3 inches below the trochanter, at which point it reaches the base of the femur (Fig. 70). The periosteum is separated downward one-half inch and then upward to the base of the trochanter.

With a two-inch osteotome the entire trochanter is removed and elevated, taking with it all the muscle attachments.

An incision is then made through the capsule beginning on the ilium and passing parallel to, and in the center of, the femoral neck to the base of the detached trochanter (Fig. 71). At the attachment of the capsule

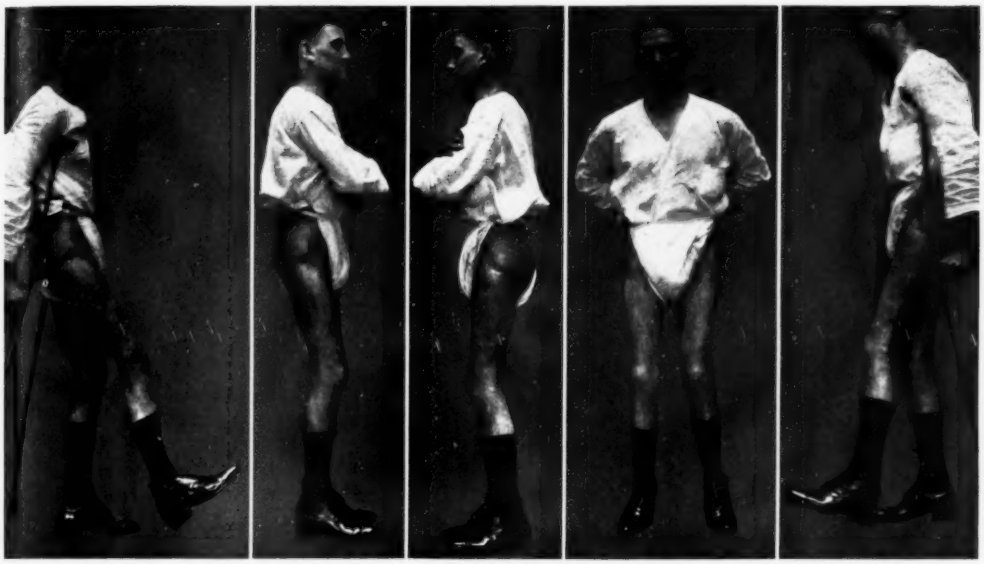


Fig. 82. Fig. 83. Fig. 84. Fig. 85. Fig. 86.

Fig. 82. Case 1. O. P. Motion in right hip 1½ years after arthroplasty.

Figs. 83 and 84. Cases 1 and 2. O. P. Lateral view, standing after arthroplasty.

Fig. 85. Cases 1 and 2. O. P. Anteroposterior view, standing, after arthroplasty.

Fig. 86. Case 2. O. P. Motion in left hip 1½ years after anthroplasty. (Patient has about twice this motion but is handicapped in further flexion by double ankylosis of the knee.

to the femoral neck, it is cut off around on both sides for a distance of 1.5 inches and retracted. A blunt dissector then frees the capsule from the neck as much as it is possible to free it.

A study of the junction between the head and the ilium is made, and then with a curved chisel, covering a small space at a time, the femur is separated from the acetabulum. Care should be taken to follow the outline of the acetabulum, as this is always hard, while the head is usually atrophied (Fig. 72).

Finally the head is freed and dislocated. With the Murphy male and female rasp (Fig. 68), the acetabulum is thoroughly reamed out and the head is thoroughly rounded (Fig. 73). Great care should be taken to remove all spicules of bone.

A piece of free fascia lata from the outer side of the opposite leg is removed and sewed around the neck of the femur by interrupted sutures. Then a purse-string suture is tied about it tightly (Fig. 74).

The head is reduced (Fig. 75). The old capsule is returned and sewed together and to the old attachments as nearly as possible. I feel that this very materially adds to stability and ensures against dislocation or a wabbly, unstable joint.

The trochanter is then pulled down to its old position and held by resuture of the periosteum with fascia originally elevated. The skin is closed and the leg placed in plaster-of-Paris cast from the nipple line to the toe, with the leg in 10 degrees abduction, complete extension, and with a little pressure over the trochanter.

The cast remains on 2½ weeks and is then removed and traction applied. Passive motions are started at the third week and should always be within the limits of pain. The patient is encouraged voluntarily to contract the thigh muscles and thereby get voluntary control early.

The patient may walk with crutches in 6 weeks and bear a little weight in about 8

weeks. Convalescence as regards motion varies with the type of individual, but all motion should be within the pain limits.

CASE 1. O. P., age 24. Patient had an ankylosis of 3 years' duration involving both hips and knees, due to an infectious process, probably neisserian in origin. (Figs. 76 and 77.)

April 12, 1920. Arthroplasty of right hip by Dr. Andrew R. MacAusland, using the technique as outlined. It was then about 3 years since the original infection. The operation was followed by some shock. The wound healed perfectly. A cast was applied.

May 17, 1920. The cast was removed and passive movements encouraged.

June 5, 1920. Patient out of bed with crutches.

June 10, 1920. He walked with crutches.

June 12, 1920. Discharged from hospital.

January 13, 1923. No pain. Motion in flexion 40 degrees. Motion in adduction and abduction in arc of 15 degrees to 20 degrees. (Figs. 78, 80, 82, 83, 84, and 85.)

CASE 2. O. P., age 24. The previous history of this case was reported under Case 1. Both hips were ankylosed. (Figs. 76 and 77.)

November 2, 1920. Seven months after the operation on the right hip, Dr. Andrew R. MacAusland did an arthroplasty of the left hip, using the regular technique.

November 29, 1920. The cast was removed. The wound healed by first intention.

December 6, 1920. Passive motions were started.

December 17, 1920. Patient was up in wheelchair. He had some sensitiveness. Motion was omitted for 1 week.

December 26, 1920. Passive motion renewed.

January 4, 1921. He walked with crutches.

January 22, 1921. He was discharged from hospital.

January 12, 1923. No pain. Motion in flexion 40 degrees. Good abduction and adduction. Excellent functional result. (Figs. 79, 86, 81, 83, 84 and 85.)

JAW

Ankylosis or greatly limited motion in the temporomaxillary articulations early assumes dangerous proportions, because of the inability of the patient to take nourishment. In young children this condition is complicated by the dangers from swelling during throat infections, so common in this type of case. Much of this infection undoubtedly arises from the inability to give proper hygienic care to the mouth and teeth. Arthroplasty is indicated in all of these cases, and, although the mortality is high in young children and the dangers of infection considerable, the relief is at times a matter of necessity. The method as described by Murphy has been accepted as standard.

An incision is made in front of the ear from one-half inch below the root of the zygoma up to the hair line. The incision may be curved in, convexed backward, passing forward under the zygoma to 1 inch in front of the ear, 2 inches above the zygoma. The L-incision gives the best access (Fig. 87).

The ankylosis is divided and a flap of temporomaxillary muscle aponeurosis dropped over the zygoma. (Figs. 88, 89, 90, 91, and 92.)

Murphy (120, b), in 1913, brought to our attention his series of nine arthroplasties of the jaw, seven for bony ankylosis and two for extra-articular fibrous fixation. The first case, of a boy with fibrous ankylosis of the left temporomandibular joint and bony ankylosis of the right, resulted in the ability to open his mouth 1 inch, 4 weeks after the operation. Now he can put an apple between his teeth. An operation on a case of fibrous ankylosis allowed the opening of the jaws to 1.5 inches 3 months after the operation.

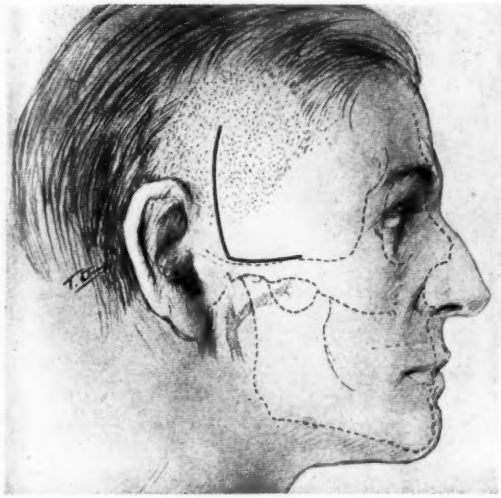
Another patient who had fibrous ankylosis could open his mouth 1 inch in 5 weeks after the operation.

As the impairment of health is involved in an ankylosed jaw, early attempts at operation were made.

Hoffa (86) collected eighteen cases: Helferich one, Lentz one, Mikulicz one, Henle one, Bilczynski one, Kusnetsoff one, Gluck two, Rochet four, Schmidt one, Foederl one, Orlow two, Meyer one, and Beresowski one. In thirteen cases in which muscle flaps were used, good results were secured, and the average separation of the incisor teeth in ten cases was 2.6 centimeters. Good results were obtained in two cases using skin flaps. In one, inserting hog's bladder, the incisors were separated 2.6 centimeters, and in two cases, using gilded plates, 2 and 1.75 centimeters.

Hoffa (86) reported two of his own cases; one of simple resection resulted in a separation of 2 centimeters and the other, using a temporal muscle flap, allowed the placing of two fingers between the jaws.

Biermann (16), in 1909, reported using a flap of the temporal muscle and obtaining a good result.



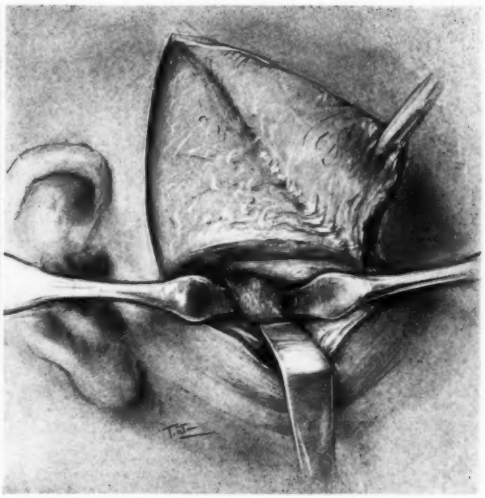


Fig. 87 (at left). L-shaped skin incision above the zygoma and in front of the ear, so placed to avoid injury to the facial nerve. (Murphy.)

Fig. 88. Skin flap retracted and zygoma and neck of mandible exposed. Two curved periosteal elevators are shown closely applied to the posterior surface of the neck of the mandible, thus protecting the internal maxillary artery from injury during division of the bone. (Murphy.)

Stein (173), in the same year, obtained a perfect recovery of a case using muscle flaps.

Baer (9, b), in 1917, recorded his series of nine cases in which eleven operations on temporomaxillary jaws had been done. One excellent result was secured in which a boy had even more motion than normal. The other cases showed good results. In Case 8, the patient could open his mouth only 3 centimeters; this case had been operated on twice by other methods and had been ankylosed 23 years.

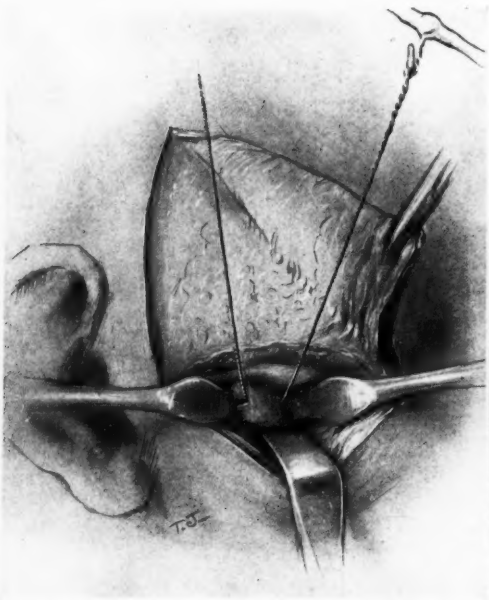
An arthroplasty on another case of marked cicatricial changes allowed the opening of the mouth to the extent of 0.5 centimeter. A baby, 18 months old and in weakened condition, died from the effects of the operation.

Baer, in his technique, first scrubs the place of operation, using potassium permanganate, oxide, and bichloride of mercury, ether, and alcohol. The incision is made parallel to the zygoma and along its lowest border; the fibers of the external pterygoid muscle are separated and the temporal muscle retracted forward. He then cuts through the periosteum of the ramus of the inferior maxillary bone and exposes the condyle. This is separated from the ramus and the temporal bone. The bones are shaped and a cuff of membrane sewed to the periosteum of the bone. The muscle is brought together and sewed, and the wound is closed. After 2 weeks the patient is encouraged to use his mouth, and movements are regulated by graduated corks.

An arthroplasty, using Baer's membrane, was reported by Osgood (131), in 1911, for complete bony ankylosis of the jaws of 2 years' duration. A slight pus discharge made necessary an incision and the removal of the membrane. Four months after the intervention the motion was good.

Neff (122) used a curved incision beginning in front of the tragus and carried up over the zygoma. Fascia was stripped from the zygoma subperiosteally. The condyle was separated from the glenoid fossa and the joint mobilized. A flap from the temporal fascia or masseter was sutured to the capsule on the inside.

Putti (145, a), in 1913, reported three jaw arthroplasties. In operation, he used Abbe's incision, resected enough bone to allow opening the jaw and interposed a free flap of fascia lata 6 by 8 centimeters, taken from the base of the great trochanter. In the post-



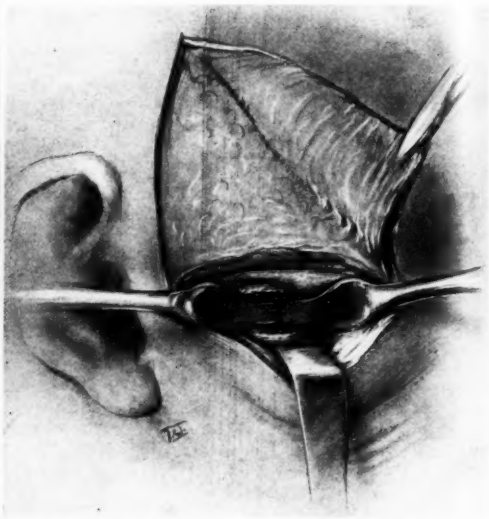


Fig. 89. Dividing the neck of the mandible with the Gigli saw. In actual operation the saw is not allowed to make so acute an angle as shown in the illustration, because of its great tendency to break when sharply bent. (Murphy.)

Fig. 90. The neck of the mandible has been divided, the cut ends of the bone separated by traction on the lower fragment and space thus provided for the interposing fascia and fat flap. The curved periosteal elevators still protect the internal maxillary artery from trauma. (Murphy.)

operative treatment, the passive exercises are regulated by means of wooden wedges.

Four months after intervention in the first case of total bilateral ankylosis of blennorrhœal origin, the patient had nearly normal motion. The after-treatment had been neglected, which accounted for lack of complete mobility. In 1 month after operation in the second case of complete congenital ankylosis of the right temporal jaw, the child could open his mouth to allow a space of 2.5 centimeters between the incisors. The third case, one of complete ankylosis between the condyle and glenoid on the left side, showed in 1 year the ability to open the mouth fully.

Blair (18), in 1914, found a flap of subcutaneous temporal fascia admirably adapted for interposition. His incision was almost completely within the hair line. Enough bone was removed to leave a space 0.5 inch wide. The immediate result was 0.75 to 1 inch opening, and this, by the use of a rubber bottle-stopper, was increased further.

Carr (28), in 1917, obtained three good results, using a modification of the Murphy method. He was unacquainted with the Murphy process at the time, but he would use it on future cases. In 18 months one patient, who had had complete fixation for years, could separate his teeth 1.25 inches. The second patient, in 3 weeks, could open and close his mouth without discomfort, and the third patient could eat in 3 days, as the muscles had not been greatly contracted.

The same year Prando (142) applied the Murphy method in a case. Although it became gangrenous, the case turned out well and the patient can open his mouth and talk clearly.

Henderson and New (81), in 1918, tabulated twenty-three cases of ankylosis of the lower jaw operated on in the Mayo Clinic during a period of 8 years. They divided the ankylosis into articular, extra-articular, and articular-extra-articular types, depending on the location of the fixation. Fifteen cases were articu-

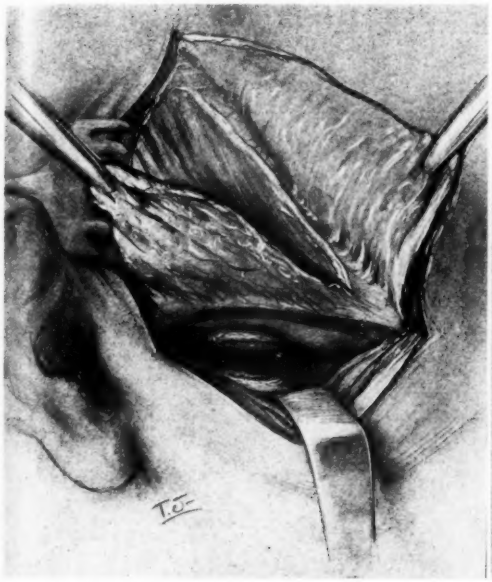


Fig. 91. The pedicled fascia and fat flap is dissected from temporal fascia and free end of flap is turned inward between divided ends of mandible and sutured securely in place with tacking stitches. (Murphy.)

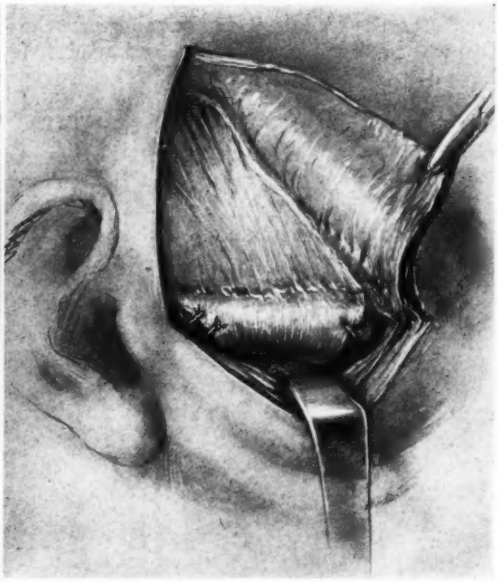


Fig. 92. The flap is now in place and the wound ready for closure. (Murphy.)

lar, five extra-articular, and the remainder articular-extra-articular. The average age of the patients was under 10 years. Excision was the basic principle of each operation, and no interposing substance was used.

The fifteen cases did well, and from 1 inch to 1.75 inches separation was obtained. In the extra-articular types the best results were secured by forcible stretching. In the articular-extra-articular type the scarring of the muscles prevented wide separation, but all the patients secured an opening of an inch.

Douglas (54), in 1919, operated for complete bony ankylosis of the left temporomaxillary joint. A horizontal incision was made just above the zygoma, the bones were separated and a flap of the temporal fascia with overlying fat interposed. The final result was excellent, although after-treatment was not carried out.

Woolsey (198) also did a similar operation and obtained a good result. He kept the jaws apart for some time after the operation.

Kerr (99), in 1920, cited four successful cases. One patient could open his mouth one-sixth inch and the second one-fourth inch. A curved, L-shaped incision was made, beginning 2 inches above and 0.5 inch in front of the ear and down to the external auditory opening, then anteriorly for 1.5 inches. The facial nerve was avoided. The condyle of the mandible was sawed off with a chain saw and a flap of temporal muscle inserted. Both patients can masticate normally. The third patient, suffering from fibrous and bony ankylosis of both joints of the mandible, with contractions of the periarticular muscles and fascia, after operation could masticate solid food. He had to guard against muscle contractions. Fourth patient after operation could open her mouth normally and masticate food.

Ritchie (152), in 1920, emphasized the importance of the after-treatment in the form of continual motion during waking hours, and wearing a rubber gag at night. He reported two cases using flaps of temporal muscle. In one case the flap was cut too short and pulled off when applied as a free flap. It was ex-

truded on the fifth day. In the other case the flap was cut large enough. The end-results of both cases were equally complete.

Chubb (34), in 1920, reported a method which he had found very successful. He divided the operation for ankylosis of the jaw into two groups according as the bone is resected from the region of the condyle or from the horizontal ramus.

The bony or fibrous ankylosis in the five cases he described was between the anterior border of the coronoid and the pterygoid aspect of the maxilla. Four cases were traumatic. One was infective in origin, and followed a bilateral suppurative arthritis of the temporomandibular joints in infancy.

In operation, the incision started in the preauricular fold at the lower level of the external auditory meatus, passing vertically upward to the level of the tip of the pinna, and curving forward below the superior temporal crest to terminate anteriorly within the hair region. The zygoma was exposed and the necessary bone removed piecemeal. The whole coronoid process was removed.

In the case of infective origin of 15 years' standing, the condylar neck region and coronoid of the left and right sides were resected. The operation was completed by a flap of temporal fascia and muscle.

The result in all cases was a gap of at least 2.5 centimeters and a very satisfactory power of mastication.

Imbert (95), in 1921, emphasized regulating the dimensions of the incisions for ankylosis of the jaw by the crossing of the facial nerve on the neck of the condyle. The upper extremity of the incision should be about 2 centimeters above the most prominent part of the tragus. The resection of the condyle is made by means of scissors and is at least 0.5 centimeter in height. He recommended the interposition of soft parts.

Dufourmentel and Darcissa (55), in 1921, presented two cases. In one, of complete temporomaxillary ankylosis of gonococcic origin, the thickness of bone was destroyed and a piece of rubber inserted. Their special apparatus was used in the after-treatment. Three months after the operation, the power and amplitude of the jaw was normal. A second case, using a muscular aponeurotic flap, failed; resection, with no interposition of rubber, resulted in a normal joint.

Bockenheimer (19), in 1922, used an incision behind the ear in freeing bony ankylosis of the jaw, of inflammatory origin. After resection, a flap of fat and fascia was interposed. In 15 months the patient could open her mouth normally. This incision had the advantage of avoiding the facial nerve and of hiding the scars.

Gilpatrick (69) recently (1922) reported a severe case of ankylosis of the jaw very similar to a case reported by Murphy. The patient had had almost complete ankylosis of the inferior maxilla for 14 years as a result of scarlet fever, complicated by an infection of both mastoids. The food had to be macerated in the plate and the boy could talk only through clenched teeth.

The right side was attacked first in operation. An incision 1.5 inches long was made in front of the right ear from a point 0.5 inch below the zygoma upward. All new bone was removed. The jaw could then be opened so that the left side was not touched. A flap of fat and fascia from the skin anterior to the original incision was interposed. In 10 days the patient could eat.

SHOULDER

The shoulder joint is rarely the seat of troublesome ankylosis. The mobility of the scapula replaces the lost motion, especially when ankylosis has occurred in the position of election; that is, abduction of 50 degrees to 70 degrees and flexion of about 15 degrees to 20 degrees forward of the frontal plane, in which position the shoulder function closely simulates normal. (Figs. 93 and 94.)

No arthroplastic measure can be considered in the absence of the deltoid muscle.

The first arthroplasty of the shoulder was reported by Nélaton (123), in 1903. The operation was done by Caville. A four-inch incision was made below the clavicle, passing externally to the coracoid process, down along the arm following the fibers of the deltoid. The head of the humerus was divided at the level of the anatomical neck. A piece of deltoid obtained by a transverse section was interposed between the surface of the humerus and

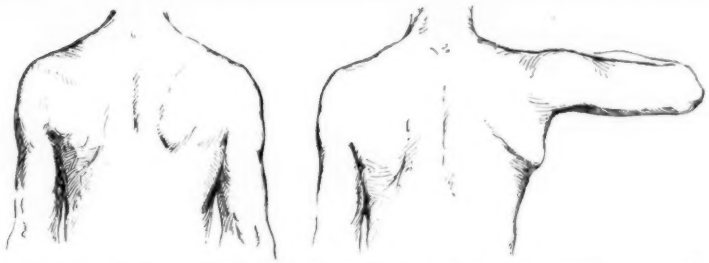


Fig. 93 (at left). Ankylosis of shoulder. Position of rest; note rotation of scapula with full rest position of arm.
Fig. 94. Ankylosis of shoulder. Full abduction obtained by rotation of scapula.

the glenoid cavity. A counter-incision was made at the same level and a thread passed through the opening, surrounding in loop form the extremity of the muscular strip. By tightening, the muscle was applied in the articular cavity. The result was good; there was passive motion in 3 days. The patient can sew. Abduction is limited.

Hofmann (87, b), in 1908, used periosteal transplants from the tibia. The results were excellent; 1 year after the operation the rotary movements were almost normal. There was active abduction with fixed scapula up to 45 degrees, after which the scapula moved with the arm.

Ochsner (125), always conservative in advising arthroplasties in ankylosis with deformity, makes a vertical incision over the middle of the deltoid muscle, and separates the fibers by the Kocher dissector. A vertical incision is made in the capsule to expose the head of the humerus. This is severed by cutting the neck with a chain saw. Strands of silkworm gut are inserted for drainage. The arm is bandaged snugly to the side and the forearm placed in a sling. He has not found it necessary to use a fascial flap. All of his patients, within a few months, have been able to use the arm as before ankylosis; they can comb their hair, etc.

In the treatment of ankylosis without deformity, in the finger, ankle, shoulder joint, or wrist, Ochsner does not consider arthroplasty indicated. In the knee, elbow, and hip, the subject is debatable. On the knee, he uses the resection method; on the hip, subtrochanteric osteotomy; and on the elbow, force only. He commends the Murphy method.

Neff (122) believed that operation in the shoulder is rarely indicated, as the scapular muscles provide good function. In case of intervention he advised reaching the joint through an incision 3.5 inches long, extending from the base of the coracoid and on a level with it, down on a line with the bicipital groove. The cephalic vein serves as a guide. The greater tuberosity is divided by means of a Gigli saw and retracted upward. The remainder of the operation is like that on the hip. Fascia or capsule may be used as flaps.

Murphy (120, e) did not report an arthroplasty of the shoulder, but in 1913 he outlined his technique on the cadaver as follows: The skin and deltoid are split and the fascia separated along the anterior margin for 4 inches. It is then elevated to expose the coracoid process with the head of the biceps and coracobrachialis. The process is divided three-fourths inch from the tip and displaced outward. The ankylosis is chiseled between the glenoid fossa and the head of the humerus, and an additional excavation of the glenoid fossa made. An incision at a right angle to the original incision is made across the chest, over the middle pectoralis major muscle. A flap of fat, aponeurosis, and pedunculated muscle is placed between the head of the humerus and the glenoid fossa. The anterior portion of the deltoid may also be used as a flap.

W. L. and C. P. Brown (23), in 1914, reported the use of a portion of the short head of the biceps for the interposed flap. It is located correctly anatomically and covered with a tendinous sheath; its attachment to the coracoid process gives the pedicle the right

Fig. 95 (at left). Ankylosis of wrist. Position of weakness (flexion); note compensatory contraction of phalanges.
Fig. 96. Ankylosis of wrist. In position of strength, a most important factor in all wrist cases.

location. An incision in the shape of a reversed "S" is made from the junction of the middle and outer thirds of the clavicle, forward and downward below the acromion process. The muscle fibers of the sulcus should be separated, coming down directly on the tendinous attachment of the inner head of the biceps. The tendon of the pectoralis major should be transfixed with a linen thread and then cut loose from the humerus; the attachment of the inner fibers of the deltoid is transfixed and severed from the humerus, which will facilitate its retraction. The forefinger of the left hand is passed beneath the inner head of the biceps, separating it from the coracobrachialis and then its sheath and fibers cut across 4.5 inches below its attachment at the glenoid cavity. About one-half the muscle, of fan-shape, 4.5 by 3.5 inches, is taken. The capsule of the joint is opened and the head of the humerus is separated from the glenoid fossa, preserving the head of the biceps if possible. Enough capsule is removed to mobilize the joint. The flap is drawn in place by three No. 1 chromicized catgut sutures, guided by the finger. If the capsule allows good motion, it should be sutured; otherwise, it should be free. If the pectoralis major has contracted, it should not be re-attached to the humerus unless it is lengthened.

The arm is put in a cast at right angles to the body with the forearm flexed, if the head of the biceps is severed. The cast is removed in 10 days.

The case of infectious origin on which the operation was done resulted in perfect motion. The patient, a carpenter, resumed his trade in 6 weeks. There was some restriction of the arc of motion because of periarticular contraction, but 2 years after intervention the patient had practically recovered the arc of motion.

Ringel (151) demonstrated a case, in which there had been a complete shattering of the shoulder region, treated by freeing of the joint and interposing a pedunculated muscle flap from the deltoid. The immediate result was so good that the patient returned to the army. Later it was found that the flap had sloughed and new bone formed. In the second operation, a broad fat and fascia flap from the thigh was fixed over the humerus. Free motion in all directions was obtained; the arc of motion was limited because of the great atrophy of the deltoid.

Thomson (180) reported a case in 1917. He made an anterior incision, removed the greater part of the head of the humerus and stitched in a piece of fascia lata from the thigh. The limb was put in the position of right angle abduction. A sufficient range of movement was secured.

Verrall (187) believes he was justified in operating on a shoulder adducted and having a small degree of painful motion, as he did not jeopardize arthrodesis in a good position. He exposed the joint along the anterior border of the deltoid and dislocated the humerus

through the wound. The glenoid was hollowed into shape and three-fourths of the humerus removed. A flap of subcutaneous tissue from over the deltoid was turned over the glenoid. He does not report his result.

Grange (74), in 1920, did an arthroplasty for ankylosis of the shoulder joint in a slightly abducted position with a good deal of destruction of the head and great tuberosity. In the operation, an incision was made along the lower border of the clavicle and down the front of the arm for 3 inches; another was made just below the acromion process to meet the first, and a third was made along the lower border of the pectoralis major. This was divided where it crosses the axilla, and the anterior half of the deltoid was cut through 0.5 inch below the acromion process, and turned down. The short head of the biceps and coracobrachialis were then divided. The humerus was exposed and rounded, and a large flap of superficial fascia turned in from the surface of the pectoralis major. The wound was closed and the arm put up with the shoulder abducted 45 degrees. Active abduction to 45 degrees, flexion to 45, and 60 degrees rotation resulted. Passive abduction and flexion could be obtained to 90 degrees.

Fig. 97 (above). Case 1. E. M. Lateral roentgenogram showing ankylosis before arthroplasty.
Fig. 98. Case 1. E. M. Anteroposterior roentgenogram showing ankylosis before arthroplasty.

WRIST

For most purposes, a wrist ankylosed in hyperextension permits satisfactory function with undiminished strength in the fingers. (Figs. 95 and 96.) Occasionally, however, lateral and flexed motions are desirable, in which case mobilization may be attempted.

Only a few cases of arthroplasties of the wrist have been reported.

Hoffa (86) records a case done by Nélaton and Ombrédanne (124) in 1905. They resected the first row of carpal bones and interposed a tendon-muscular flap. The outcome was poor; ankylosis recurred in four months.

Hoffa (86), himself, did two wrist arthroplasties. In one he inserted a magnesium plate. A fistula resulted, which necessitated the removal of the plate; ankylosis recurred. In the other operation he resected the first row of carpal bones and inserted a fat and fascia flap taken from the proximal side of the wound. Two months after the operation, there was free motion of several degrees. Nine months later there was good mobility in the wrist and excellent function.

Stein (173), in 1907, in Bier's clinic, did an arch-shaped resection of the bones and interposed a muscle flap. In 2 years the passive motion was good, but the function was unsatisfactory, due to the patient's cutting the flexor tendons.

Baer (9, c), in 1909, reported a case of congenital union between the head of the radius and the ulna. Chromicized pig's bladder was interposed. Three months after the operation, supination was possible to 100 degrees, but a twist in the radius prevented it going farther.

Two more cases were cited by Baer (9, a) in 1918. One of congenital synostosis of the radial head and ulna, in which the animal membrane was used, gave voluntary motion of 110 degrees. Marked curvature of the radius made normal conditions impossible. The other case of bony ankylosis between the ulna and radius, when chiseled apart, gave 90 degrees supination and pronation.

L. Durán (57), in 1910, did an arthroplasty, using Baer's membrane. Painless mobility of about 50 per cent of normal resulted in 1 month.

Figs. 99 and 100. Case 1. E. M. Ankylosis before arthroplasty.

Fig. 101 (above). Case 1. E. M. Anteroposterior roentgenogram after manipulation. (MacAusland.)
Fig. 102. Case 1. E. M. Lateral roentgenogram after manipulation. (MacAusland.)

Mention has been made of an arthroplasty by Whitman (193) in 1911, in which a section representing the first row of carpal bones was removed and the deformity corrected. The record is incomplete.

Neff (122), in 1912, outlined his technique of operation on the wrist: A convex incision with the convexity downward through the skin, on the dorsum of the wrist, extending from the ulnar to the radial side; division of the posterior annular ligament and retraction of the extensor tendons laterally; division of the capsule transversely, low down on the carpal bones and dissection of it upward, leaving it attached to the radius and ulna; resection of the first row of carpal bones in an arched direction with convexity upward; inversion of the posterior capsular flap between the articular surfaces. If there is not sufficient capsule a fascia lata flap or rectus aponeurosis may be used. The wound is sutured, and passive and active motion and massage begun on the eighth day.

Murphy (120, f), in 1913, reported three wrist arthroplasties. In one, of infection, an incision was made over the end of the radius on the back of the arm, and a flap of superficial fat and fascia interposed between the radius and the scaphoid. Limited motion resulted; ankylosis did not recur. The second case was that of a woman who had multiple arthritis of 6 years' duration. Elbows, ankles, knees, and hips were involved. On one wrist he made a longitudinal incision over the ulnar styloid process, dissected down on the ulna, and with an elevator separated the muscles, tendons, and arteries. Care was taken not to dissect the periosteum from the bones. A pedicled ulnar flap from the outer surface of the wrist was passed over the ends of the bones, and the tip was brought to the radial side of the joint, where it was fastened. A radial flap was interposed in like manner. The arm was dressed in slight anterior flexion and held in an elevated position.

Five weeks later, Murphy operated on the other wrist, the carpal bones and ulna and radius of which were completely ankylosed. Only a radial incision was made. The lower ends of the ulna and radius were resected about five-eighths inch to three-fourths inch. The division of the ankylosis was semicircular with concavity upward. A flap from the dorsum of the radial side of the forearm was interposed and fastened to the joint capsule on the ulnar side.

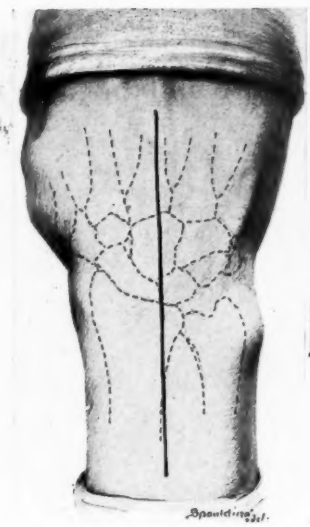


Fig. 103. Line of incision used in author's technique.

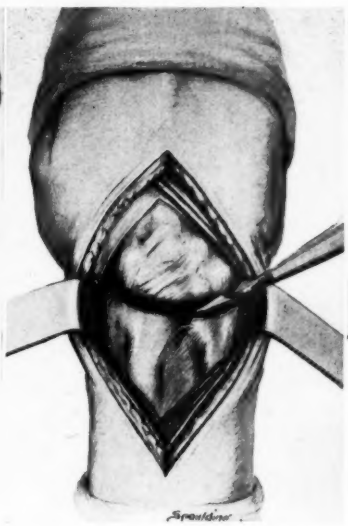


Fig. 104. Cutting out the joint line with curved chisel and removal of a small amount of bone.

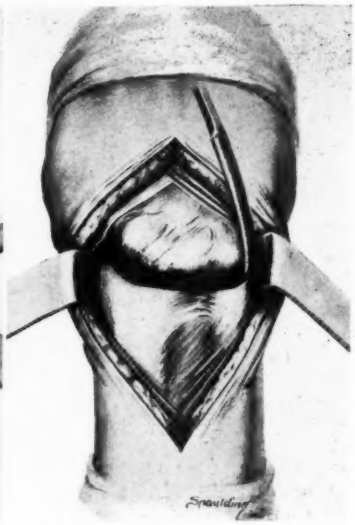


Fig. 105. Making convex and concave surfaces smooth with file.

The right wrist had an almost normal conformation; the left wrist luxated slightly.

In 1922 I did an arthroplasty in the following case:

Case 1. E. M. On May 12, 1922, patient fell through a pane of glass, cutting the right wrist. This was followed by infection, resulting in ankylosis in deformity of 25 degrees flexion. Scars from numerous incisions during sepsis were present.

When I first saw the patient, he had power in all tendon groups, but was unable to make a fist, and the wrist was ankylosed in 25 degrees flexion deformity. Roentgenograms showed considerable atrophy and periarthritic changes with some posterior displacement of the tip of the ulna (Figs. 97 and 98). Manipulation into the hyperextended position was done in August, 1922, and a plaster applied.

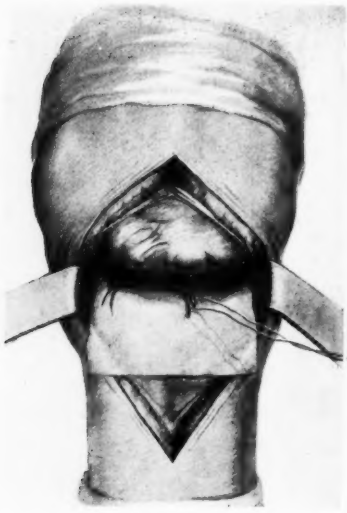
August 23, 1922. Patient could bend fingers. Use encouraged while in plaster.

September 25, 1922. Plaster cast removed and hyperextension splint applied. Baking and massage daily. Wrist in good position and, although motion of fingers had increased and the wrist was in hyperextended position, there was no wrist-joint motion (Figs. 99 and 100).

October 30, 1922. Roentgenogram shows ankylosis between the scaphoid, semilunar, and the end of the radius (Figs. 101 and 102). Arthroplasty of the wrist was advised.

November 7, 1922. Operation.

Operative technique—author's method. Posterior incision 5 inches long (Fig. 103). Skin and superficial fascia clamped off with towels. Incision then made over fascia and posterior ligament and both retracted. Common extensors retracted outward, and the extensors of the thumb were retracted inward. An incision was then made over the capsule of the old joint, which was carefully saved and retracted laterally. With a curved chisel the scaphoid and semilunar were separated by osteotomy from the radius. The lower end of the radius was re-shaped and made to approximate as near as possible the normal radial end. One-fourth inch of the carpus was removed and the carpus very carefully rounded to conform to the opposing radial end (Figs. 104 and 105). A piece of fascia was then removed from the outer side of the lower thigh of the right leg and sewed between these surfaces with interrupted chromic gut. It was sutured first to the anterior capsule of the joint, then to the posterior capsule, well over the head of the radius (Figs. 106 and 107). The old capsule of the joint was then closed with interrupted chromic catgut and the skin was closed with continuous catgut. The hand



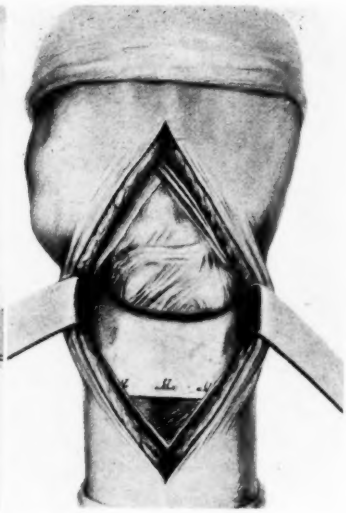


Fig. 106 (at left). Suture of fascia lata to anterior capsule.
Fig. 107. Suture of fascia lata to posterior capsule.

was placed in a cast in hyperextension. The plaster was allowed to remain on 3 weeks and then was split down the side and gentle passive motions begun (Figs. 108 and 109). Active motions were encouraged.

November 20, 1922. Treatment continued. There was no discharge. An X-ray showed separation between carpus and radius as a result of arthroplasty (Figs. 110 and 111).

November 27, 1922. Hand was in good condition. No pain, and use of the fingers had increased. Hyperextension splint applied. To have daily baking and massage with motion.

January 22, 1923. There was 10 degrees lateral motion in the wrist, hand flexion 5 degrees, hyperextension 35 degrees to 40 degrees (Figs. 112 and 113). The patient could almost make a fist. His inability completely to close fingers was due to the old sepsis involving the sheaths of the tendons. He has no pain and wishes to go to work.

I feel that the function will increase as time goes on.

FINGERS

Unfortunately, the phalangeal joints lend themselves poorly to plastic work, due to the fact that, in most cases, the injury which causes the ankylosis also damages the tendon sheaths and the tendons. As a result rapid and extensive atrophy follows, rendering the skin and subcutaneous tissue very delicate. So tender are all the structures with which the operator comes in contact that, even though he uses the best technique, he is baffled. Not until the metacarpal row is reached can the operator feel that the chances of success favor plastic work, and here only in the presence of intact tendons and sheaths.

In 1908, Hofmann (87, b) reported a case of fibrous ankylosis of two interphalangeal joints of the same hand, in which he interposed periosteal transplants from the tibia. Six weeks after the operation there was good passive but no active mobility.

Eloesser (60) secured a good result by implanting a finger joint from the cadaver.

Goebell (72) also obtained a good movable joint by implanting a toe joint in a finger resected for severe arthritis deformans.

Hammesfahr (78), in 1912, reported transplanting the joint of the second toe with capsule and ligaments between the proximal phalanx of the middle hand bone. The result has been very satisfactory; the patient can move the joint freely in all directions; there is only slight lack of bending ability.

In 1922, Oehlecker (126) reported good results, after 6 years, in transplanting the entire finger joints taken from the patients

Fig. 108.

Fig. 109.

Fig. 108. Case 1. E. M. Lateral roentgenogram 2 months after arthroplasty.

Fig. 109. Case 1. E. M. Anteroposterior roentgenogram 2 months after arthroplasty.

Fig. 110.

Fig. 111.

Fig. 110. Case 1. E. M. Roentgenogram after arthroplasty. (In plaster.)

Fig. 111. Case 1. E. M. Roentgenogram after arthroplasty. (In plaster.)

themselves and from other persons. The results in the autoplastic cases were the better.

Roepke (156), in 1913, operated for finger-joint ankylosis and mentioned that he had success with free fat transplantation.

Payr (134, b), in 1914, recommended arthroplasty of the fingers, using pedunculated implants of flaps of tendon sheath from the palmar side of the hand. He reported two arthroplasties of the interphalangeal joints with favorable results.

Gallagher (67), in 1915, reported the result of an arthroplasty for traumatic bony ankylosis of a proximal interphalangeal joint of the fourth finger. He does not describe his method. In 2 months the patient could lift and carry on the joint 7.75 pounds. There was voluntary flexion to about 45 degrees and extension to about 170 degrees. He has devised a simple apparatus to give proper exercise to the joint.

Hamilton (77) reported success in arthroplasties on the phalangeal and metacarpophalangeal joints. The same principles are involved as in arthroplasty on the larger joints. The incision for all phalangeal joints is made parallel to the long axis of the finger. A midlateral incision is made on either side down to the capsular ligament. For metacarpophalangeal joints an incision is made at the junction of the posterior and lateral surfaces on either side. The bones are mobilized by sawing two nicks about one-sixth inch apart. All fragments of capsular ligament are removed. In the thumb he recommends the use of a free flap. Extension is applied by means of a splint and adhesive plaster. Passive motion is instituted after 2 or 3 weeks. A case is cited of virulent polyarthritis which left a man with bony ankylosis of the thumb joint and proximal phalangeal joint of the index finger of the right hand. Within 6 months after arthroplasty the patient was accepted as a naval recruit by the United States Navy.

Verral (187), in 1920, reported his belief that the proximal joints can be treated by arthroplasty, using free fascial graft. Metacarpophalangeal joints afford a good field; for the first, second, and fifth fingers enough subcutaneous tissues can be obtained locally; for the third and fourth fingers he used fascia lata. The flap is cut in a strip 3 inches by 1 inch, folded in half and sewed up into a bag which is slipped over the metacarpal head and secured by catgut.

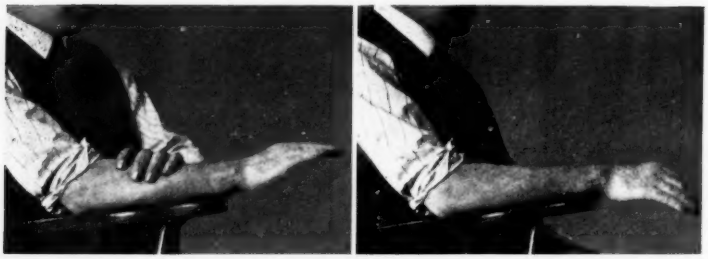


Fig. 112 (at left). Case 1. E. M. End-result 2 months after arthroplasty. Voluntary hyperextension 35 to 40 degrees.
Fig. 113. Case 1. E. M. End-result plantar flexion, 2 months after arthroplasty.

Hesse (84), in 1922, reported on fourteen cases of finger mobilization. On the middle joint, he made a lateral incision, resected the head of the basal phalanx after separation of the lateral ligaments. In two cases, a layer of periosteum from the tibia was placed over the resected end. In 10 months, one patient had complete working ability of the finger. In 3½ months, the other patient had active mobility of 120 degrees and normal extension. In the twelve other cases, free fascia lata transplantation was used. In ten cases, the patients were benefited, securing satisfactory mobility. In one case, the fascia sloughed and there was no betterment. In another case, there was shortening to about 2 centimeters, active motion in the basal joint 100 degrees, but no movement in the middle joint and strong lateral motion. In four of the cases, it was necessary to remove the fascia.

ANKLE

Ankylosis of the tibio-astragaloid joint, if at a right angle without varus or valgus, is a functional joint with which, in my opinion, we should not interfere. Although a weight-bearing joint may be obtained from arthroplasty, instability, pain, and sensitiveness may result.

In a slight ankylosis of the ankle in good position, there is only a slight limp. If, after experience in years to come, stability may be assured with an arc of motion without pain and sensitiveness, then and only then will arthroplasty be indicated.

Ochsner (125), in 1912, reported that in case operation was necessary for ankle deformities he used the resection method, removing the necessary amount of bone in a transverse line. His cases have been successful, and the patients can usually walk in 2 weeks. In case of severe ankylosis without deformity, he is opposed to arthroplasty.

Ashhurst (7), in 1915, cited the case of a boy with bony ankylosis of the right ankle, with the foot in a position of equinus at 140 degrees with the leg. There were deep scars on the leg and foot. Ashhurst incised down to the bone on the outer side of the tarsus from below the external malleolus to the extensor tendons. The soft parts were raised from the bones. Another incision 1 inch long was made on the inner side of the ankle joint in front of the internal malleolus and parallel to the tibia. The wounds were joined by burrowing. A wedge of bone, cut with its base on the dorsum of the tarsus and its apex at the posterior surface of the ankle joint, rendered the foot movable. Fascia lata from the left thigh was inserted. The result was free voluntary motion of about 10 degrees, with the foot not quite at a right angle. The hallux valgus caused extreme deformity.

A second operation was performed in which the head of the metatarsal was removed and the toe put in position. The tendon of abduction hallucis was inserted. The tendo achillis was lengthened by the "Z" operation. One month later there was free voluntary motion in the ankle from 85 degrees to 95 degrees and passive motion from 85 degrees to 110 degrees. Dr. Ashhurst looked for further improvement.

One would hardly feel that 10 degrees motion in an ankle warranted the attempt to mobilize it. An ankylosis, corrected into proper position, would be useful and mobili

Fig. 114. Line of incision as used by author.

Fig. 115. Flap dissected back.

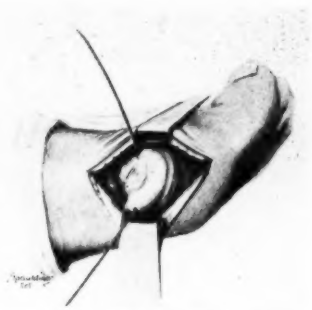


Fig. 116. Excision of small amount of bone.

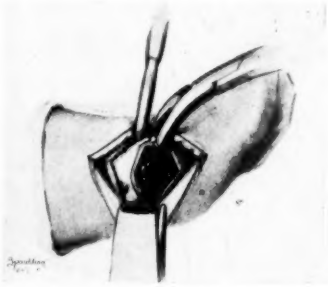


Fig. 117. Rounding of distal end of metatarsus.

Fig. 118. Filing and smoothing of metatarsal shaft.

Fig. 119. Flap sewn in place.

zation might result in a sore and painful joint.

Steindler (174), in 1916, reported two cases in which pedunculated fascia flaps were used. One case was the result of a fracture of the astragalus and collum astragali, with supination deformity, and the other the result of fracture of the internal and external malleolus and impingement of the body of the astragalus on the fractured end of the tibia and fibula. No results were recorded.

Ceballos (30), in 1917, used a free flap of fascia lata in a case of complete tibiotarsal ankylosis in a right angle. No result is given.

Baer's (9, a) one case of arthroplasty on the ankle was reported in 1918. It is of interest, as a bone graft of fibula was inserted before the arthroplasty could be made. The membrane was inserted between the astragalus and the fibula. Voluntary motion of 30 degrees was obtained, and the patient walks with comfort.

Reich (150), in 1919, issued his views on arthroplasty of the ankle joint, which he considered one of the most satisfactory mobilizations. Observations were made in various cases operated upon, which showed that the desired 20 degrees to 30 degrees range of mobility was not obtained. This, Reich believed, was because in operation the tibia was again made concave and the astragalus convex. As the mobility attained by the natural joint is closely connected with the height of the astragalus over the posterior segment of the foot, the slightest diminution of this height interferes with the movement, for the margins of the concave plane of the tibia strike against the astragalus anteriorly and posteriorly. In arthroplasty a decrease in the height of the astragalus seems unavoidable.

Reich recommended an inversion of the natural form of the portions of the joint, making the surface of the tibia convex and the astragalus concave. The flaps of fat are laid

Fig. 120. Case 1. D. R. Anteroposterior roentgenogram 20 months after arthroplasty.

Fig. 121. Case 1. D. R. Lateral roentgenogram 20 months after arthroplasty.

between the surfaces. With this inversion, the axis of the joint mobility will be changed downward without the lateral ligaments being adapted to it, but this new mobility is not so much of the joint as of the rocking motion which furnishes a useful substitute for the former.

METATARSOPHALANGEAL JOINTS

The metatarsophalangeal joints, with the exception of the first metatarsophalangeal joint, never call for arthroplastic measures. These joints, in fact, are rarely stiff. The fascia-flap method gives an excellent result in the operation on the first metatarsophalangeal joint.

Operative technique—author's method. After thorough preparation of the part and the application of a tourniquet, an incision is made, beginning on the lateral aspect of the first phalanx and extending parallel to the shaft, curving to the lateral dorsal surface over the region of the joint and then back to the lateral aspect of the first metatarsal (Fig. 114). This flap is then dissected down and retracted with double hooks. A curved incision is then made through all remaining tissue, including bursa, capsule, and fascia. This incision begins near the base of the first metatarsal on the lateral plantar surface and sweeps about one-fourth inch over the base of the first phalanx to a corresponding position on the lateral dorsal aspect of the first metatarsal. The flap is dissected back, exposing the old joint (Fig. 115). About five-eighths inch of the head of the first metatarsal is then removed and all edges smoothed with a file or shoemaker's rasp (very important) (Figs. 116, 117, 118). A chromic suture is then passed from the plantar surface into the cavity and through the flap, making a mattress suture, and then the needle is passed through the cavity to the outer plantar surface and the flap firmly pulled into the cavity over the end of the metatarsal head (Fig. 119). The skin is closed with continuous catgut and a dry dressing applied. The toe is bandaged in inversion and slight plantar flexion, opposite to the usual deformity.

Weight-bearing is allowed in 2 or 3 weeks, at which time passive motion and hydrotherapy are of use. Activity depends upon the amount of swelling and pain, and motion is limited accordingly. The results of mobilization of the joint are excellent.

CASE 1. D. R., age 45. In February, 1921, I operated for a case of double hallux valgus, using the technique I have outlined.

For years this patient had complained of increasing pain and stiffening in the toe joints. More recently she complained of loss of motion and enlargement of the joints. Physical examination showed a marked exostosis on the top and inside of both toe joints, with limited motion. Excision of the distal head of the first metatarsus and insertion of a bursal flap was advised.

February, 1921. In the operation 0.5 inch of the distal head of the first metatarsus was removed.

April 8, 1921. Good motion. Anterior arch padding. Subsequent convalescence without pain or swelling. Elastic cuffs advised.

November 17, 1922. Motion perfect. (Figs. 120 to 125.)

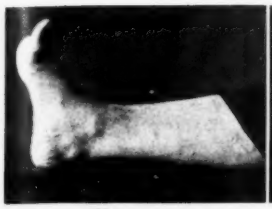


Fig. 122.

Fig. 123.

Fig. 124.

Fig. 125.

Fig. 122. Case 1. D. R. Toes of right foot in dorsi-flexion 21 months after arthroplasty.

Fig. 123. Case 1. D. R. Toes of right foot in plantar flexion 21 months after arthroplasty.

Fig. 124. Case 1. D. R. Toes of left foot in plantar flexion 21 months after arthroplasty.

Fig. 125. Case 1. D. R. Toes of left foot in dorsi-flexion 21 months after arthroplasty.

Murphy (120, b), in 1913, secured good motion in 18 days in a case of ankylosis of the phalangeal and metatarsophalangeal joints. Leucorrhœa of 4 years' duration had been the cause of stiffness. Murphy made an incision on the dorsum of the toe and used a flap of fat and fascia from the inner side of the foot with base upward.

In 1916, Murphy (120, b) outlined his operative technique for hallux rigidus as follows: A curved incision with convexity outward along the extensor tendon; incision of the tendon to elongate it; metatarsal head resected and bursal capsule used as the interposing flap.

Putti (145, a), in 1913, reported an arthroplasty on an ankylosed metatarsal phalanx of the hallux. He made a longitudinal cut on the internal side of the metatarsal phalanx, removed two large sesamoids that contributed to the stiffness, removed all capsule, and interposed a flap of fascia lata, wrapping the two surfaces. The extensor tendon was shortened. A plaster cast was applied to keep the hallux in a dorsal position. The postoperative treatment was regular. The stitches were removed on the ninth day, and gentle passive movement was begun.

BIBLIOGRAPHY

1. Ahrens. Muenchen. med. Wchnschr., 1908, iv, 2138.
2. Albarran. Cited by Hoffa, loc. cit.
3. Albee. Orthopedic and Reconstruction Surgery. 1918, p. 965.
4. Allison and Brooks. Surg., Gynec. & Obst., 1913, xvii, 645.
5. Ameyaga, G. de. Ann. Surg., 1907, xlvi, 617.
6. Appel. Deutsche Ztschr. f. Chir., 1916, cxxxvi, 508.
7. Ashhurst. Ann. Surg., 1915, lxii, 302; 378.
8. Axhausen, G. Beihefte z. med. Klin., Berl., 1908, iv, 23.
9. Baer. (a) Am. J. Surg., 1918, xvi, 170. (b) Tr. South. Surg. Ass., 1916, 1917, xxx, 126. (c) Johns Hopkins Hosp. Bull., 1909, xx, 271.
10. Baldwin. West London M. J., 1915, xx, 111.
11. Barton, J. Rhea. N. Am. M. & S. J., Phila., 1827.
12. Bazy. Bull. et mém. Soc. chir., Par., 1907, xxxii, 520.
13. Bérard. Dict. de méd., 1838, xxiii, 440.
14. Beresowski. Cf. Orlow, Deutsche Ztschr. f. Chir., 1903, xxxvi, 400.
15. Berger. Bull. et mém. Soc. chir., Par., 1901, xxix, 998.
16. Biermann, Karl. Die funktionellen Resultate der Gelenkresectionen mit besonderer Beruecksichtigung der Methoden zur Erhaltung der Beweglichkeit. Dissertation, Berlin, 1909.
17. Bilczynski. Zentralbl. f. Chir., 1898.
18. Blair. Tr. South. Gynec. Ass., 1914, xxvi, 435.
19. Bockenheimer. Deutsche med. Wchnschr., 1922, xlviii, 729.
20. Bolognesi. Arch. internat. de chir., Gand, 1912–13, vi, 69.
21. Brandstrup. Hosp.-Tied., Københ., 1917, No. 27, 663.
22. Brown. California State J. M., 1916, xiv, 146.
23. Brown, W. L., and C. P. J. Am. M. Ass., Chicago, 1914, lxii, 1389.
24. Buchmann. Zentralbl. f. Chir., 1908, No. 19.
25. Burlew. California State J. M., 1918, xvi, 237.
26. Campbell. (a) J. Orthop. Surg., 1921, iii, 430. (b) Ann. Surg., 1922, Nov., 615.
27. Carnochan. Arch. de méd., 1860, p. 284.
28. Carr. Tr. South. Surg. Ass., 1917, p. 161.
29. Cavazzani. Gazz. d. osp., Milano, 1899, p. 37.
30. Ceballos. Prensa méd. argentina, Buenos Aires, 1917, iv, 400.
31. Ceccarelli. Riforma med., Napoli, 1917, xxxiii, 1173.
32. Chaput. (a) Bull. et mém. Soc. chir. Par., 1912, n.s., xxxviii, 452. (b) 1915, xli, 1540.
33. Chlumsky. Zentralbl. f. Chir., 1900, xxvii, 921.
34. Chubb. Brit. M. J., 1920, i, 256.
35. Cifuentes. Rev. de espec. méd., Madrid, 1909, xii, 73.
36. Clark. Med. Press. & Circ., Lond., 1914, n.s. xcvii, 30.
37. Conrad. Dissertation, Kiel, 1912.
38. Corner. Med. Press. & Circ., London, 1913, n.s. cxvi, 723.
39. Cotton. Surg. Clin., North America, 1922, ii.
40. Cramer. Arch. f. klin. Chir., 1901.
41. Crosti. Atti d. Soc. lomb. di sc. med. e biol., Milano, 1916–17, vi, 48.

42. CZERNY. Arch. f. klin. Chir., 1872, xiii, 227.
43. DARLING. Physician & Surg., 1913, xxxv, 71.
44. DARTIGNES. Rev. d'orthop., 1900, xi.
45. DAUTRELPONT. Arch. f. klin. Chir., 1868, ix, 917.
46. DAVIS. Johns Hopkins Hosp. Bull., 1911, Oct.
47. DEFONTAINE. Rév. de chir., 1887, No. 9.
48. DELAGENIÈRE. Bull. et mém. Soc. de chir. de Par., 1917, xliii, 2195.
49. DELBERT. Gaz. méd. d. Par., 1912, lxxxiii, 117.
50. DELBET. (a) Bull. et mém. Soc. de chir. de Par., 1903, xxix, 1172. (b) Ann. de la Policlin. de Par., 1912, xxiii, 284.
51. DENK. Arch. f. klin. Chir., 1912, xcvii, 458.
52. DEUTSCHLANDER. Soc. des chir. de l'allemagne du sud-ouest, 1911, Nov.
53. DIEL. Gaz. d. hôp., Par., 1913, lxxxvi, 1727.
54. DOUGLAS. Ann. Surg., 1920, lxxii, 636.
55. DUFOURMENTEL, L., and DARCISSA. Bull. Soc. de pédiat. de Par., 1921, xix, 62.
56. DUPUY. Thèse de doct., Toulouse, 1903.
57. DURÁN, L. Rev. Ibero-Am. de cien. méd., Madrid, 1910, xxii, 366.
58. DURANTE. Trattado di Medicina Operatoria di Durante e Leotta, vol. ii, Chirugia degli Arti, 113.
59. EDMUNDS. Med. Press & Circ., 1912, xciv, 574.
60. ELOESSER. California State J. M., 1913, xi, 485.
61. ELY. Bone and Joint Studies. Leland Stanford Junior Univ. Publications, 1916.
62. EXNER. Wien. klin. Wchnschr., 1913, xxvi, 1821.
63. FERGUSON. Med. Times & Gaz., 1861, i, 601.
64. FINOCHIETTO. Semana méd., Buenos Aires, 1918, xxv, 590.
65. FOEDISCH, PRAG. Ztschr. f. Heilk., xvi, No. 4. Zentralbl. f. Chir., 1896, No. 5.
66. FRISCH, von. Wien. klin. Wchnschr., 1911, xxiv, p. 922.
67. GALLAGHER, P. J. Am. M. Ass., 1915, lxv, 1180.
68. GILBERT. Texas State M. J., 1915, xxxi, 226.
69. GILPATRICK. Boston M. & S. J., 1922, clxxxvi 374.
70. GLUCK, TH. Deutsche méd. Presse, vii, 1.
71. GODDU. Boston M. & S. J., 1921, clxxxiv, 198.
72. GOEBELL, W. Muenchen. med. Wchnschr., 1913, lx, 356.
73. GRAFF. Deutsche med. Wchnschr., 1915, xli, 1502.
74. GRANGE, C. D'O. Lancet, Lond., 1920, ii, 554.
75. GREIFFENHAGEN. St. Petersb. med. Ztschr., 1913, xxxviii, 93.
76. HALLOPEAU, P. Bull. et mém. Soc. de chir. de Par., 1920, xlvi, 1447.
77. HAMILTON, G. Texas State J. M., Fort Worth, 1919, xiv, 353.
78. HAMMESFAHR. Deutsche med. Wchnschr., 1912, xxxviii, 390.
79. HARRIS. Texas State J. M., Fort Worth, 1913, ix, 213.
80. HELFERICH. (a) Verhandl. d. deutsch. Gesellsch. f. Chir., 1894, xxiii, 504. (b) Zentralbl. f. Chir., 1894, suppl., p. 35.
81. HENDERSON. Am. J. Surg., 1918, xvi, 30.
82. HENLE. Dissertation A. Lesser, Tuebingen, 1898.
83. HERZBERG. Dissertation, Berlin, 1913.
84. HESSE, E. Arch. f. klin. Chir., 1922, cix, Jan. 1.
85. HESSERT. Surg. Clin., Chicago, 1918, ii, 129.
86. HOFFA. Ztschr. f. orthop. Chir., 1906, xvii, 1.
87. HOFMANN. (a) Ztschr. f. orthop. Chir., 1906, xvii, 1. (b) Beitr. z. klin. Chir., Tuebingen, 1918, lix, 717.
88. HOHLBAUM. Arch. f. klin. Chir., 1922, cxvii, 647.
89. HOHMANN. Berl. klin. Wchnschr., 1918, lv, 222.
90. HOHMEIER and MAGNUS. Verhandl. d. deutsch. Gesellsch. f. Chir., 1914.
91. HOKE and ANDREWS. Atlanta J.-Rec. Med., 1908, x, 132.
92. HOERHAMMER. Muenchen. med. Wchnschr., 1917, lxiv, 1338.
93. HUEBSCHER, C. Corres.-bl. f. schweiz. Aerzte, xxvi, 785.
94. HUGUIER. (a) Thèse de doct., Par., 1905. (b) Tribune méd. Par., n.s., 1909, xli, 197.
95. IMBERT, L. Lyon chir., 1921, xviii, 572.
96. JUDET. Recherches de chir. experimentale. Paris: Baillere, 1908.
97. KATZENSTEIN. Berl. klin. Wchnschr., 1916, No. 24.
98. KENNEDY. Tr. Roy. Acad. M. Ireland, Dublin, 1915, xxxiii, 223.
99. KERR. Surg., Gynec. & Obst., 1920, xxx, 518.
100. KIRSCHNER. Verhandl. d. deutsch. Gesellsch. f. orthop. Chir., X Kong., Berl., 1910, 222.
101. KLAPP, R. Zentralbl. f. Chir., Leipz., 1909, xxvi, 1196.
102. KLEINSCHMIDT. Muenchen. med. Wchnschr., 1919, lxvi, 520.
103. KOCHER. Chirurg. Operations Lehre.
104. KOENIG. Lehrb. d. Chir., 1894.
105. KOLAZEK. Beitz. klin. Chir., 1912, lxxviii, 155.
106. KUETTNER. Beitr. z. klin. Chir., Tuebingen, 1911, lxxv, 1.
107. KUSNETSOFF. Vrach. St. Petersburg, 1898, xix, 1275; 1311.
108. LENTZ. Cong. franç. de chir., 1895.
109. LERICHE, M. R. Lyon chir., 1921, xviii, 547.
110. LEXER. Surg., Gynec. & Obst., 1908, vi, 601.
111. MACAUSLAND. (a) J. Am. M. Ass., 1915, lxiv, 312. (b) Surg. Clin., N. A., 1922, ii, 959. (c) Surg., Gynec. & Obst., 1921, xxxiii, 223.
112. MAUCLAIRE. Bull. méd. Par., 1913, xxvii, 66.
113. MCCURDY. Pennsylvania. M. J., Athens, 1914–15, xviii, 606.
114. MCILHENNEY. New Orleans M. J., 1901.
115. MCKENNA. J. Am. M. Ass., 1917, lxix, 891.
116. MEYER. Klin. Abend 18, October, 1895.
117. MEYER, O. Deutsche med. Wchnschr., 1909, xxxv, 1931.
118. MIKULICZ. Verhandl. d. deutsch. Gesellsch. f. Chir., Berl., 1895, xxiv, 350.
119. MOSZKOWICZ. Berl. Ztschr. f. Chir., 1917, cv, 168.
120. MURPHY. (a) Tr. Am. Surg. Ass., 1904, xxii, 313. (b) Ann. Surg., 1913, lvii, 593. (c) Murphy's Clin., 1914, iii, 523, 1159. (d) J. Am. M. Ass., 1915, 851. (e) Murphy's Clin., 1916, v, 641, 189. (f) Tr. Am. Surg. Ass., 1913, xxxi, 67. (g) J. Am. M. Ass., 1905, xliv, 1479, 1573, 1671.
121. NARATH. Zentralbl. f. Chir., 1896.
122. NEFF. Surg., Gynec. & Obst., 1912, xv, 552; 592.
123. NÉLATON. Bull. et. mém. Soc. de chir. de Par., 1902, xxviii, 687.
124. NÉLATON and OMBRÉDANNE. Rév. d. Orthop., 1905, 25, vi, 39.
125. OCHSNER. Illinois M. J., 1912, xxxi, 596.
126. OEHLECKER. J. Am. M. Ass., 1922, lxxix, 778.
127. OGILVY. New York M. J., 1921, cxiv, 566.
128. OLIVIERI. Semana méd., Buenos Aires, 1917, xxiv, 127.
129. OLLIER. Traite des resections et des operations conservatrices, etc., Paris, 1885.
130. ORLOW, L. W. Deutsche Ztschr. f. Chir., Leipzig., lxvi, 399.
131. OSGOOD. Boston M. & S. J., 1911, clxv, 86.
132. OWEN. Ann. Surg., 1914, lix, 426.
133. PAINTER. Canada Lancet, Toronto, 1912–13, xlvi, 332.

134. PAYR. (a) Deutsche Ztschr. f. Chir., 1914, cxxix, 341. (b) Arch. f. klin. Chir., Berl., 1914, cvi, 235.
135. PEREIRA. Brazil-méd., Rio de Jan., 1906, xx, 361.
136. PERTHES. Muenchen. med. Wchnschr., 1917, lxiv, 919.
137. PETRASCHEWSKAJA. Verhandl. d. wiss. Ver. d. Aerzte d. stadt Obuchow-Krankenh. in St. Petersburg, 22, 1913.
138. PETTIS. Physician & Surg., 1913, xxxv, 352.
139. PHEMISTER and MILLER. Surg., Gynec. & Obst., 1918, xxvi, 400.
140. PLUMMER. Surg., Gynec. & Obst., 1917, xxiv, 509.
141. POMPONI. Gior. di med. mil., Roma, 1912, lx, 418.
142. PRANDO. Prensa méd. argentina, Buenos Aires, 1917–18, iv, 390.
143. PRINGLE. Tr. Roy. Acad. M., Ireland, Dublin, 1915, xxxiii, 220.
144. PUPOVAC. Wien. med. Wchnschr., 1914, xxvii, 151.
145. PUTTI. (a) Arch. d. orthop., Milano, 1913, xxx, 1; 205. (b) Chir. d. organi di movimento, Bologna, 1919, iii, 627. (c) J. Orth. Surg., 1912, iii, 421. (d) Chir. d. orig. di movimento, Bologna, 1917, i, 1. (e) Arch. d. orthop., Milano, 1919, xxxv, 272. (f) J. Orth. Surg., Lincoln, Nebraska, 1920, ii, 530.
146. QUÉNU. (a) Bull. et mém. Soc. chir., Par., 1902, xxviii, 724. (b) Ibid., 1903, xxix, 112. (c) Ibid., 1905, xxxi, 622.
147. QUIGLEY, D. T., and STEVENSON, E. C. West M. Rev., Omaha, 1913, xviii, 137.
148. RECHET. VIII Cong. chir., Lyon, 1894; Arch. prov. Chir., 1896.
149. REINER. Deutsch. Ztschr. f. Chir., 1910, xiv, 209.
150. REICH, A. Zentralbl. f. Chir., 1919, xlvi, No. 6, 97.
151. RINGEL. Deutsche med. Wchnschr., 1916, xlii, 713.
152. RITCHIE. J.-Lancet, 1920, xl, 479.
153. ROCHER. J. de méd. de Bordeaux, 1920, i, 215.
154. ROCHET. Thèse de Fondet, 1895.
155. RODGERS. New York J. M. & S., 1840.
156. ROEPKE. Deutsche chir. Kong., 1913, 116.
157. ROEREN. Arch. f. Orthop., Muenchen. u. Berl., 1922, xx, 36.
158. ROSER. Zentralbl. f. Chir., 1886, p. 36.
159. ROVSING. Tr. XI North Surg. Cong., Gothenburg, 1916.
160. RYERSON. Surg. Clin., Chicago, 1917, i, 197.
161. SAYRE. A New Operation for Hip Joint in Bony Ankylosis. New York, 1869.
162. SCHANZ. Muenchen. med. Wchnschr., 1904, p. 2228.
163. SCHLOFFER. Deutsche med. Wchnschr., 1917, xliii, 1183.
164. SCHMERZ. Beitr. z. klin. Chir., Tuebingen, 1911, lxxvi, 261.
165. SCHMIDT. Khirurgia, Moscow, 1899.
166. SCUDDER. Boston M. & S. J., 1906, clv, 375; Ann. Surg., 1907, xlv, 297; 1908, xlvii, 711.
168. SEGALE. Beitr. z. klin. Chir., Tuebingen, 1913, lxxxi, 259.
168. SEXSMITH. J. Med. Soc. N. J., 1920, xviii, 333.
169. SIEVERS. Freie Vereinigung der Chirurgen Sachsens, Leipzig, x, 1912; Zentralbl. f. Chir., 1913, No. 23.
170. SILFVERSKIÖLD, N. J. Am. M. Ass., 1922, lxxviii, 856.
171. SIMON. Berl. klin. Wchnschr., 1914, li, 235.
172. SOURDAT. Méd. prat., Par., 1910, vi, 806.
173. STEIN. Dissertation, Bonn, 1907.
174. STEINDLER, A. J. Iowa State M. J., 1916, vi, 284.
175. SUMITA. Arch. f. klin. Chir., Berl., 1912, xcix, 755.
176. TAVERNIER. Lyon chir. 1920, xvi, 527.
177. TAYLOR. Pennsylvania M. J., 1912, xvi, 294.
178. TEXTOR. Wurzburg, 1843, viii, 4.
179. THOM, V. Deutsche Ztschr. f. Chir., Leipz., 1910–11, cviii, 424.
180. THOMSON. Edinburgh M. J., 1917, xix, 176.
181. TORREY. J. Michigan M. Soc., 1913, xii, 318.
182. TUBBY. (a) Am. J. Orthop. Surg., 1914–15, xii, 433; 377. (b) Med. Press & Circ., Lond., 1914, n.s. xcviii, 324.
183. TUFFIER. Soc. de chir. de R., 1901.
184. TURNER. Edinburgh M. J., 1914, n.s. xii, 433.
185. VAUGHAN. G. T. Surg., Gynec. & Obst., 1911, xiii, 80.
186. VERNEUIL. Arch. de méd., 1860.
187. VERRALL, P. J. Clin. J., Lond., 1920, xlix, 76.
188. VULPIUS. Muenchen. med. Wchnschr., 1914, Mar. 17.
189. WEGLOWSKI. Zentralbl. f. Chir., 1907, Apr. 27.
190. WERDE. Deutsche med. Wchnschr., 1916, xlii, 1287.
191. WHEELER, W. I. de C. Brit. J. Surg., Bristol, 1921, ix, 242.
192. WHITACRE. Lancet-Clin., Cincin., 1908, xcix, 424.
193. WHITMAN. Ann. Surg., 1911, liv, 860; 1916, lxiii, 503.
194. WIENER. Am. J. Surg., N. Y., 1911, xxv, 281.
195. WILLE. Norsk. Mag. f. Lægevidensk., Kristiania, 1911, ix, 40.
196. WOLLENBERG. Ztschr. f. aerztl. Fortbild., Jena, 1915, xii, 267.
197. WOLFF. Verhandl. d. deutsch. Gesellsch. f. Chir., 1882.
198. WOOLSEY. Ann. Surg., 1920, lxxii, 636.
199. ZELLER. Jahresk. f. aerztl. Fortbild., Muenchen, 1919, xii, Hft. 25.

NOTE.—Figures 56 to 63 and 87 to 92 are reproduced from the *Surgical Clinics of John B. Murphy;* Figures 64 to 67 from *Ann. Surg.;* Figures 42 to 53 from *Chir. d. org. di Movimento.*

ARTHROPLASTY[1]

By Dr. P. SANTY, Lyon, France

THE very particular manner in which we have viewed the question of arthroplasty in this report must first be explained. The ideas we wish to broadcast are not simply our own, but rather those of a school. We shall discuss especially what surgery at Lyon has evolved in the mobilizing treatment of ankyloses, in applying the methods of joint resection outlined by Ollier, and how these methods appear at this time to a surgeon who did not know the founder of the method but who has been raised in the tradition of this school.

Arthroplasty as performed nowadays seems to us the result of the infinite number of attempts which surgeons and experimenters have performed to give original mobility and solidity to ankylosed joints.

The many reports written about the treatment of ankyloses, of which certain ones (as the report of Baumgartner at the French College of Surgery in 1913) are very full and rich, show conclusively, and it is quite in accordance with our ideas, that the question has been almost decided, at least as regards treatment of the upper extremity. Beginning with the first investigations which were undertaken, the subject has been very complicated because success did not follow the interposition of different kinds of tissues and articular transplants. We have now returned to a very carefully studied and precise technique which makes failure exceptional, but which in many ways is not so very different from that used in the beginning of our work.

To Ollier is due the credit of first realizing the possibility of mobilizing certain ankylosed joints and putting his method into practice. His ideas have been regularly and precisely developed, thanks to modern surgical technique, and form the basis for arthroplasty. The method of aponeurotic interpositions seems to have taken its place in the realm of practicable operations.

Our co-reporters may bring before us important personal statistics which better than all comment will enable us to appreciate the value of the procedures they employ. It would have been impossible for us, even had we made a collection of all the French observations published, to submit important and conclusive statistics. In fact, up to the last few years, arthroplasty has been undertaken among us only timidly and in a few isolated cases.

On the other hand, it has been interesting to us to endeavor to show that Ollier's technique is still upheld as is shown in the different ideas expressed regarding mobilization of ankylosed joints. Since its creation this technique has been especially bettered by the general improvements in surgical technique and aseptic operating, but on the whole has remained very like that which Ollier described at length in his treatise. Aside from the knee, for which the comparison does not hold good, we are able to show that mobilizing resection and anthroplasty give rather close results, differing chiefly in the postoperative course. In the light of these facts it is apparently important to see what part of the old method holds good in comparing the results obtained with it to those actually obtained from arthroplasty by means of aponeurotic interposition.

The general principles on which Ollier insisted from the time of the announcement of his conception of the mobilizing treatment of ankylosis by resection were as follows: Joint resection can result in the formation of a new joint both movable and solid provided the removal of bone is sufficiently great to permit a free play of the resected ends on each other. This removal should include all ossifiable tissues such as remains of the joint capsule which are greatly modified in bony ankylosis and which are liable, if allowed to remain, to lead to bony union. This removal Ollier defined under the name of interrupted subperiosteal resection.

Attributing to the muscular insertions a preponderating rôle in the reconstruction of

[1] Presented before the International Surgical Society, London, July 16–21, 1923. Translated by Kellogg Speed, M.D., F.A.C.S., Chicago.

the bone ends and the solidity and mobility of the new joint, he has prescribed for each joint the best means of trimming off the articulations so that perfect conservation of the juxta-articular muscle insertions may be maintained.

Finally after studying the postoperative results, by means of electric stimulation and massage of the muscles to preserve their contractility, he left nothing to be desired in his treatment for joint mobilization which aimed at securing for a joint its original mobility.

ANKYLOSIS OF THE SHOULDER

Ankylosis of the shoulder is a condition for which the surgeon is infrequently consulted, because, in most of the cases, there is so little disturbance of function. "Thanks to the constantly increasing movement of the scapula the patient can follow a manual trade, which may even be laborious, and he is inconvenienced only in his arm movements, especially in abduction and elevation."

When one can promise the patient a joint which is both solid and movable as well as having increased function, operation will be offered legitimately, and Ollier believes that the results obtained are evidently preferable to ankylosis. However, in many cases of ankylosis of the scapula and humerus, satisfactory use of the upper extremity is possible, thanks to the movement of the scapula which gradually increases and compensates to a certain extent for the impotence which results from the scapulohumeral fusion. Especially is this true if the humerus is fixed in such a manner that the movements of the forearm are easily accomplished and over a wide enough range when the elbow is flexed at a right angle. This presupposes that during the process of the disturbance or in the course of the ankylosing trauma, one has taken care to immobilize the arm in slight abduction and external rotation.

However, there are cases in which these precautions have not been taken and one finds the arm in a position of internal rotation which, even when the scapula aids, results in the forearm and hand being held in contact with the anterior surface of the chest when the arm is in an attitude of rest alongside the body. For writing or feeding purposes, these arms are almost, if not quite, useless.

In such cases, without mentioning arthroplasty, two operative procedures are possible: osteotomy and resection.

In one case of Leriche's which I saw in 1919, a subcapital osteotomy followed by immobilization in slight abduction and external rotation, thanks to the perfect mobility of the scapula, gave a very satisfactory functional result. If, however, the scapula does not have free movement, resection can and should give satisfaction.

Although rare, from time to time instances of fixation of the scapula have been observed among soldiers wounded by projectiles which, after having traversed the shoulder joint, have shattered the border of the scapula and carried out large masses of soft parts at the wound of exit. In such lesions cicatrization of the wound results in scauplohumeral ankylosis and locking together of the thorax and scapula on account of adherence to the thoracic wall of the anterior and posterior scapular muscle masses. In such wounded men it is important to mobilize the shoulder joint; resection accomplishes that perfectly.

Resection will be attempted only if the condition of the shoulder girdle muscles indicates the possibility of securing active mobility. Ollier emphasizes the importance of care in resecting the soft parts, periosteum, and joint capsule and prudence in resecting the bony part proper so that only so much as is necessary be excised to obtain both mobility and solidity. It is important to specify the point at which resection of the humerus should begin. This should be in the juxta-capital area and should extend if possible in the depression of the anatomical neck, excising the internal part of the greater tuberosity region in such a manner as to permit freedom of movement in abduction. After resection it is of great advantage to mold the upper end of the humerus. In the classical technique the manœuvres of mobilization are progressive and, with the osteogenetic restoration of the epiphysis, lead slowly to the functional adaptation of the

upper end of the humerus. This complement of the operation itself, which is easily performed, will surely simplify in a rather large measure the first attempts at mobilization by hastening the reciprocal adaptation of the surfaces of the new joint.

Resection will yield good results only when followed by immobilization in abduction and slight traction, with the arm suspended in a sling. Such procedures permit almost immediate passive mobilization of the resected joint. In certain war wounds, the results which follow resection at the shoulder joint when no infection develops are such as to convince one that resections are better than simple ankylosis of the shoulder joint in a good position.

ANKYLOSIS OF THE ELBOW

When Ollier first advocated his method, in 1869, and carried out his technique of resection, his work on the elbow joint yielded results which completely realized his expectations. What can we add to the indications he prescribed? "Resection gives me a limb more useful than an elbow ankylosed in the best position. Ankylosis of the elbow at a right angle or slightly extended should not be considered as a happy result which must invariably be considered as satisfactory. One is forced to demand as well movement in the joint if the patient is of an age which would insure success from operation, and of a social status which makes operation necessary." As contra-indications Ollier would consider only the age of patient and the ability of the musculature to resume its function. If in the presence of ankylosis at a right angle, operation was considered contra-indicated because of the social status of the patient, such should not hold true in the presence of ankylosis at an obtuse angle or if the arm is in extension, because in such cases the indication for operation is urgent and operation should be done as soon as possible to avoid an increase in the muscular atrophy.

The possibility of producing an ankylosed elbow with double mobility (radio-ulnar and humero-ulnar), by joint resection according to Ollier's method, was an established fact when its originator described it in his treatise on resections, and has only tended to strengthen the practice of his school. However, resection of the elbow is not always considered favorably and the violent attacks upon its use by certain surgeons, during the last years of the war and since, make discussion worth while.

In general the great objection offered by the opponents of the method is the danger that flail elbow may follow resection. However, the results secured by Ollier and the large number of his pupils should convince one that instead of incurring the danger of flail elbow, correct and typical resection is apt to show as its main drawback, a tendency of the joint to stiffen up again, and the surgeon must struggle against this for many weeks.

It is very interesting to note moreover that the fundamental principles laid down today by those who advocate arthroplasty as indispensable factors in securing success are quite the same as those defined by Ollier in describing his mobilizing resection of the elbow joint, namely:

a. Removal of at least 5 centimeters of bone in most cases, sometimes more.

b. Sub-periosteal interrupted resection by excising all around the joint every bit of the excess thickened periosteum, and remnants of joint ligaments and capsule which have undergone osseous infiltration.

Although it is not part of this paper to discuss operative technique, it seems essential to review the important points very briefly. The posterior external incision described by Ollier should be used. It permits the operator to inspect the wound carefully and offers no serious inconvenience when one completes the resection by the bony release from within at the level of the elbow. The least satisfactory point in the technique is perhaps the liberation of the insertion of the triceps by means of the periosteal elevator. This insertion is nearly always shredded by the elevator so that only a small band of doubtful character is preserved. The resection and saving of a small layer of the olecranon, which can later be reimplanted on to the ulna along with the triceps tendon, certainly constitutes a very appreciable improvement in

the operative technique and deserves wider use. It is nearly always possible to break through the ankylosis by means of a rasp or chisel if simple flexion of the forearm does not suffice. The next step in the operation is resection of the bone. It is important to make this as typical and clear cut as possible. On the humerus, resection should be made at the thickening of the condyles or just above them at a point where the diaphysis begins to enlarge; intra-epicondyloid section is the best (Leriche). On the forearm side, resection should be carried below the coronoid process in the neck of the radius. In this technique removal of the radial head is without doubt an essential factor in restoring pronation and supination. Resection of the radio-ulnar synostosis by means of the chisel, as proposed by Putti, could be of value only in very limited fusions between the bones. These resections can result only in greatly helping the remaining tissues in adapting themselves to their new function. Trochleaform resection of Defontaine is not without interest; likewise, oblique section of the elbow leaving an olecranon mortise is advantageous.

Ollier made a separate subdivision for ankylosis following unreduced dislocations of the elbow. Such cases are accompanied by most extensive peri-articular ossification and show the greatest tendency to re-ankylosis after resection, so that he performed only a humeral resection in order to preserve all the force of the triceps by allowing its insertion to remain intact. Experience gained in the war has shown that partial resections give uniformly bad results, especially on account of the tendency to re-ankylosis which endangers even the superior radio-ulnar joint.

It must be kept in mind that resection for ankylosis must be liberal. Failure to do so, we shall see in studying results, means re-ankylosis. The care given the resected elbow and the course in the weeks following operation are of great importance from the standpoint of results. An aseptic course and union *per primam*, by reducing inflammatory reaction, have most certainly modified the functional prognosis of mobilizing resections. Inflammatory reaction produces a great osteogenetic tendency as Ollier observed. He guarded against it by using antiseptic dressings and drainage.

We must not feel, however, that the great difficulty against which we must constantly struggle is exuberant bony regeneration which follows resection. Two means of avoiding this regeneration are either mobilization or complete rest in plaster of Paris, and these means are available to every surgeon and he should consider them from all angles. In 1889 Ollier wrote: "Now everyone is convinced of the necessity of not letting joints stiffen and of mobilizing them as soon as possible. This idea is so generally and emphatically advocated that it has been overdone, and while it does not seem necessary to reverse our ideas regarding mobilization, we must warn young surgeons against any erroneous interpretation they may make of them. It seems to us that everywhere near and far surgeons are overdoing; they are so convinced that mobilization is necessary that they treat the patient roughly and when he will not permit that then with delicacy. Many times we have seen deplorable results from too great zeal. We have seen joints become ankylosed after brutal movements. It is bad practice to attempt to obtain in 8 days what ordinarily requires months to secure. It is not a question of overcoming resistance or of breaking up adhesions; it is the problem of causing the formation of an apparatus for sliding movement and of organizing an interlying serous surface."

There is nothing to add to Ollier's statement as to the manner in which resected joints should be mobilized. It requires at least 3 months of patient effort to secure results and improvement progresses both as to active and passive movements. At times, especially in the young, some time during or at the end of the second month, when the process of bony repair is at its height, the movements will suddenly become stiff and the elbow grows warm and painful. When this occurs one should immediately place the arm in complete immobilization in a plaster gutter and let it remain there for 8 to 10 days, when the joint will be found to have regained its former mobility and may again be mobilized (Leriche). Under the

supervision of the surgeon, mobilization should be practiced for 3 to 3½ months; after this the patient may continue his exercises, consulting the surgeon at intervals.

From an anatomical standpoint, the result may be quite perfect. In 1912 Vallas exhibited before the Surgical Society of Lyon a specimen secured 4 years after resection for bony ankylosis following rheumatism. The specimen showed bony restoration, a capsular ligament, and even a synovial membrane. This was particularly interesting inasmuch as there was a very unique unpartitioned joint cavity with very simple and very solid ligamentous reconstruction about it. The result was perfect funtionally. Ollier's treatise contains examples of excellent results after mobilized resection for ankylosis, some of which were obtained after several unsuccessful attempts followed by re-ankylosis.

However, as he himself states, it was always necessary to use ample and prolonged drainage because of the imperfections in operative technique at that time. The results of his operations were very rarely rigorously aseptic, that is, there was always a more or less intense inflammatory process which lent itself as a favorable factor for the reformation of abundant bone.

Today, when we can be reasonably certain of our operative technique and can close the resected joint without drainage, we are assured of more simple and more rapid results, and instances of re-ankylosis are less often found, while the average results are better.

We shall not discuss the results of experimental research work from multiple or non-homogeneous sources. Reports of such work abound everywhere, and it is interesting to note that the surgeons who have done simple resections and resections with interplaced tissues for ankylosis of the elbow agree that the results are about equal. Thus, Chaput in July, 1917, brought before the Surgical Society of Paris three cases which had been treated for bony ankylosis. Two of them had been operated upon by simple mobilizing resection and the third by interposition of a fat transplant. The results in the three cases were satisfactory, and Chaput concluded that tissue interposition was useless. L. Berard and Sencert[1] have published similar results. Nove-Josserand, in 1893, reviewed the subject and came to a conclusion favoring complete extensive resection. He does not appear to have changed his opinion, as shown in a case of resection with interplaced tissue which he recently presented before the Surgical Society of Lyon.

During the war Leriche had the opportunity of working on many wounds of the elbow and of observing the different stages of evolution, and he published a series of very excellent results after extensive resections of the elbow for post-traumatic bony ankylosis. In a report presented in 1919 at the Sixth Interallied Surgical Conference he concluded as follows: "I have resected fistulous ankyloses of the elbow, painful ankyloses, ankyloses in vicious positions and some ankyloses in good position in patients who desired joint movement. In 15 cases I used Ollier's resection. Only extensive resections gave me good results; when I tried to be conservative, ankylosis returned. Out of the 15 cases I obtained good results in 9, 2 of which were very good, 2 were insufficient, and 4 re-ankylosed."

Must one then conclude that arthroplasty on the elbow is fruitless and should one remain faithful to resection alone? The facts we have mentioned, together with many others, show that Ollier's resection is sufficient to obtain the result desired, and that it is possible to obtain this result in a simple manner, and the technique is easy of execution.

It would seem that aponeurotic interposition and molding of the osseous surfaces have their advantages in gaining time and in smoothing over that trying period for both patient and surgeon during the progressive mobilization in the first few weeks. Anthroplasty does not dispense with long and painstaking postoperative care, but it does make it less laborious and avoids those outbursts of inflammatory reaction which often threaten and sometimes compromise the results of operation if resection is done without flap interposition.

[1] Société de Chirurgie de Paris, 1918, June 5.

ANKYLOSIS OF THE WRIST

Mobilization for ankylosis of the wrist is seldom indicated, because a wrist ankylosed in good position—half extension with persistence of the motions of pronation and supination—is often compatible with considerable functional use of the hand.

It is very different when the wrist is ankylosed in flexion with lateral deviation and limitation of finger movements on account of injury to the tendons. Such a case is almost always caused by the sequelæ of radiocarpal trauma, and its treatment must necessarily become a part of the delayed treatment for fractures and dislocations of the carpus, and often fracture of the radial epiphysis. In an instance of this character, the loss of function is concerned as much with tendon disturbance as with adhesion of the median nerve, and operation makes it possible to treat the whole difficulty.

Here again orthopedic resection of the wrist has a very interesting history and roentgenographic study of carpal lesions in traumata of the radius has enriched it by numerous observations.

In two published observations in his treatise, Ollier has described the method of treatment and shows the possibility of bringing about mobility along with functional power in the hand by means of total resection of the carpus, extending or not extending to the radial epiphysis. Other types mentioned are those resulting from inflammatory ankylosis, old osteomyelitis, and the ankyloses of rheumatism.

In 1908 Vallas[1], by means of six observations, established the necessity for complete carpal resection to restore mobility to wrists completely ankylosed. However, one must not overlook the fact the such a resection is to be used only on real ankyloses, that is, total ankyloses of the carpal and radiocarpal joints, verified by roentgenogram. With the exception of this class of cases, partial resection limited to the first row of the carpal bones or particularly to the bones directly concerned in the trauma, the lunate and navicular most often, will suffice, especially if the trauma is relatively recent and if the loss of power is due only to incomplete stiffening and to pressure on the surrounding parts by deformed or displaced carpal bones. It resolves itself into a question of great difference in indications rather than a question of different treatment for identical lesions.

Can gonorrhœal ankyloses and those following suppurative arthritis when the hand is placed in a vicious position, be benefited by extensive carpal resections? Frequent changes in the muscles and tendons must greatly reduce the indications in these cases.

The results of orthopedic resections of the wrist depend more than is the case with all the other joints on the condition of the muscles and tendons. Skeletal shortening of from 3 to 4 centimeters which results but rarely from carpal resection necessitates first of all a functional adaptation which will terminate satisfactorily if the muscles and tendons are intact. However, Ollier describes a procedure for shortening tendons which is useful whenever the resection is carried up to the radial epiphysis and he emphasizes the importance of the bony shortening. On the other hand, if improvement has previously been obtained, if the tendons are slightly movable, and if there exists great muscular atrophy, the results obtained will show the effect.

At the wrist as at the elbow the parallel between orthopedic resection and arthroplasty is easily sustained, with this important fact in favor of arthroplasty by interposition, however, that it permits a less extensive resection of the wrist (limited to a single row of bones) and interferes less with the use of the hand as a bony lever.

Moreover, it unquestionably favors mobilizing movements from the start and simplifies the postoperative care: a fact clearly demonstrated in a recent case. The remote results of resection should not be very different from the results of arthroplasty.

ANKYLOSIS OF THE HIP

The respective operative indications as a result of the many varieties of ankylosis of the hip are such that, even now in spite of all the progress made along this line, the surgeon hesitates to use the mobilizing operation except in a very limited number of cases.

[1] Société de Chirurgie de Paris, 1908, Jan. 29.

At the hip, as at the knee, the problem of obtaining mobility and solidity at one and the same time is a particularly delicate one. It is frequently the case that the surgeon prefers to leave the limb as it is, if the position of the joint is good, if the thigh is straight out, and slightly abducted. If the angle of the joint is vicious, it is considered good practice simply to change the position. Osteotomies are performed with an infinite variety of resulting positions of the leg according to the prevailing fashion. The tendency to avoid the joint zone itself and to attack only the trochanter or the trochanteric region as has been carefully specified by Ollier is very well explained by the fact that operative trauma, even an osteotomy, may cause, without any hope of direct cure, the lighting up of a tuberculosis—a frequent cause of the ankylosis.

It is this same dominating thought which has caused the attempts to perform indirect mobilizing operations such as the para-articular enarthrodeal osteotomies of Rhea Barton and of Vincent[1] to which Rocher[2] added interplaced muscle.

If Ollier declared himself as less in favor of direct operation on an ankylosed hip for fear of altering its mobility only at the expense of its length and the solidity of the limb, he none the less studied the possibility of it, and showed under what conditions wide resection of the hip, the technique of which he described, would bring the desired result.

The typical indication for such resection is ankylosis of both hips straight out. He formulated a plan by which to treat such disability which was everywhere copied and followed, up to the time of the appearance of modern operations for mobilizing joints. He advised resection first on the side where the muscular atrophy was the least pronounced and where the best conditions for the re-establishment of movements were found. Following this a subcervical osteotomy on the opposite side should be done. He believed that failure of the first attempt with re-ankylosis or stiffening did not contra-indicate another attempt at typical resection of the second joint operated upon.

[1] Vincent, December 11, 1890.
[2] Rev. de chir., 1900, April 10

Resection, such as Ollier described for the hip, can claim to result only in a movable hip in the face of a considerable number of bony excresences, so that weight is carried often on the partly resected greater trochanter. The fact remains as a principal factor in the mobility that there is complete loss of contact between the upper end of the femur and the acetabular area. But this very condition is also the cause of the ascent of the liberated femur toward the iliac fossa in spite of precautions taken during the operation to reform an acetabular buttress out of the periosteal and capsular débris rolled up over the upper margin of the acetabulum and to maintain the leg in a long-continued abduction by means of strong traction.

It is not our purpose to enter here into the technical details of resection for ankylosed hip, but it is worth while to call attention to the difficulties which the operator encounters. As soon as he has reached the neck of the femur, it is easy to continue on to the acetabular region and to break through the ankylosis with a chisel, or first to resect the neck so that attack may be made secondarily on the ankylosis. Sometimes it is found, however, that the bony mass which binds the femur to the pelvis makes the landmarks unrecognizable. It increases the size of the joint out of all ordinary proportions and changes its level, so that the freeing of the head becomes very difficult. For extirpation of the bony mass resulting from fusion of the head of the femur and the acetabulum, "peri-trochanteric arthrotomy" (Lorentz) is used. It is very difficult to perform the molding of a new joint in such a case.

In view of the facts mentioned, there seems no doubt that instead of extensive resection of the hip with its uncertain and in all cases very imperfect results, plastic arthrotomy followed by the interposition of tissue which has given such excellent results in the hands of Murphy, Baer, and Putti is the preferable operation. On the other hand when we find that the molded bony mass offers considerable resistance because of its volume and consistency, one is much inclined to employ the simpler technique which still assures a satisfactory result.

It has been my opportunity to observe with Leriche[1] two cases of bilateral ankylosis of the hips in patients on whom an extensive resection of the cervico-acetabular bony mass has given satisfactory results with a movable new joint which allowed between 40 and 45 degrees flexion of the hip on the pelvis. It is extraordinary to note that in one of these two patients the joint thus resected had undergone 7 years previously an arthroplasty according to Murphy's method, and after several months of apparent success had terminated in a new ankylosis in the course of an attack of infectious disease.

In the hip, then, in most cases, extensive subperiosteal resection gives mobility only at the price of deformity and instability of the lower limb, which is considerably restricted in its function. Such resection should be reserved for use only in those cases of extensive peri-articular ossification which expose the technique of modern arthroplasty to great difficulties and hindrances and which permit one to obtain with wide subperiosteal resection firm new joints of the correct range of motion.

ANKYLOSIS OF THE KNEE

Our ability to trace a still existing parallel between mobilizing resection and arthroplasty ends completely in its application to the knee joint.

As has been repeated by former authors many times, many French surgeons since the time of Ollier, and his own school at first, believed until recently that ankylosis of the knee in good position—that is to within a few degrees of complete extension—was the curative result to seek and maintain in all joint disturbances which threatened the integrity of the articular surfaces. As late as 1913 the French Congress of Surgery at the close of its discussion admitted that rectilinear ankylosis of the knee was to be held in respect.

As Tavernier emphasized, in his report at the meeting of the French Orthopedic Society in 1921, Ollier, who obtained experimentally on animals extremely interesting results in the restoration of movable joints after resection, had never, outside of a case of limited ankylosis between the patella and femur, dared to apply to human surgery the technique which had given him a glimpse of the possibilities to be attained from its use. What he stated after defending the method "from the viewpoint of the real interest of the patient, bony welding after complete bony resection," was: "But is this the last word in surgical art and should we forever renounce the attempt to find for the knee what one obtains so regularly for other joints, for the elbow and for the wrist?"

The two great difficulties which caused so many operators desirous of improving ankylosed knees to hesitate so long were the problems of obtaining movement in a positive manner as well as movement associated with a satisfactory joint stability. In a word they wished to obtain, as Payr said, in speaking of the patients on whom he had operated, not a joint *de luxe* but a truly first-class joint capable of doing its work.

Now the problem seems solved. The most convincing statistics of Putti, Baer, Murphy, and Payr show conclusively the possibility of restoring movement to an ankylosed knee by means of an arthroplasty including the interposition of tissue. However, the perusal of these statistics and numberless reports shows first of all that the results vary according to the methods used and the operators. Besides indications for operation or rather the contraindications are very different and vary according to the author.

There is a great variety of causes of ankylosis of the knee, the causes being even more numerous perhaps than for other joints. They may be classified under the following heads: tuberculosis, infectious arthritis, gonorrhœal arthritis, traumatic arthritis and osteomyelitis, polyarticular diseases resulting in ankylosis. A tuberculous etiology is considered by some as a positive contra-indication to arthroplasty (Putti, Lexer), by others it is considered as yielding very unfavorable results (Murphy), others on the contrary (Baer and Payr) have secured good results with arthroplasty after this disease.

A similar diversity of opinion exists which has as its basis the anatomical character of

[1] Société de Chirurgie de Lyon, 1921, April 14.

the ankylosis; the fibrous or bony nature of the synostosis has also been the subject of diverse views since Putti announced that he would rather deal with a bony ankylosis with atrophied muscles than with the fibrous form even when the muscles retain a more vigorous condition.

Finally the factor of the position of the ankylosed joint has been considered as important. All operators who have performed arthroplasty prefer to operate on a knee which is completely extended or only slightly flexed. The position of pronounced flexion is a source of great difficulty because it involves wide bony resection and a compensatory lengthening of the flexor tendons. However, it cannot be denied that one will always be strongly inclined to advise an operation for mobilization in the presence of a vicious position, even if the operation finally results in the straight position in case of failure.

This brief statement of the various factors which guide the surgeon in making his choice of operation simply aims to set forth what possibilities other operations than arthroplasty offer for ankylosis of the knee.

Cuneiform resection will certainly improve many vicous ankyloses flexed in a bad position, where one feels that operation for mobilization would not be beneficial, possibly on account of the extreme degree of flexion or on account of the wretched state of the muscle or an account of the cicatricial contraction of the coverings of the joint. Quite recently Professor Berard reported before the Surgical Society of Lyon a series of observations on ankyloses in flexed positions following tuberculous arthritides of childhood. He straightened out the flexed limbs means of cuneiform resections, and, in his opinion, considerable improvement followed the operation.

As a disadvantage to arthroplasty surgeons have mentioned the fact that because of the extreme difficulty in performing the operation it is necessary for the surgeon to specialize in this one limited field so that he may become efficient in performing the various technical manœuvres. In addition, Putti mentions specifically that he never undertakes operations of this character except on carefully selected patients and after an extensive knowledge of the surgery of joints in general. Every one will subscribe to these precautions.

I have had an opportunity of collaborating with Leriche in two arthroplasties done according to Putti's technique. The first case was one of gonorrhœal arthritis really a little too recent, and one which resisted a prolonged course of vaccine treatment before the operation. As the psychic condition of the patient was of no help in the post-operative treatment, the ankylosis rapidly reformed. The second case in which the patient suffered from multiple ankyloses gave a very fair result.[1]

Recently we[2] operated together upon a young girl suffering from a traumatic ankylosis in the extended position, and the result after 3 months promises to be very favorable since she now has active flexion of more than 45 degrees.

It is true that one can profit only by familiarizing himself with the necessary operative technique and that can be had only by much experience in performing arthroplasty.

Other published French cases, rather few in number, but nearly all favorable, can not help but encourage their authors to multiply their attempts. Cases reported by Tavernier, Mauclair and Rocher at the French orthopedic meeting are instructive. They were not all successes but they bore witness to the possibility of arriving rapidly and surely at results comparable to those reported in the statistics quoted above. The case on which Lenormand operated, after Murphy's method, and which he showed before the Paris Surgical Society on the 28th of June, 1922, was an excellent result, of 19 months' standing and with a flexion of about 50 degrees.

From the results obtained I believe we are justified in subscribing to the conclusions proposed by Tavernier 2 years ago at the third meeting of the French orthopedic society when he stated that he considered that for the knee arthroplasty was indicated not alone

[1] Société de Chirurgie de Lyon, 1921, March 10, Lyon chir., 1921, p. 547.

[2] Société de Chirurgie de Lyon, 1923, Jan. 11.

in the presence of vicious ankylosis, all types of which require operation, but was also indicated in the presence of ankylosis with the limb in a straight extended position when the accessory conditions are favorable.

Resection should be reserved for those cases for which arthroplasty is contra-indicated on account of the nature and the position of the ankylosis and the condition of the musculature and coverings about the joint.

TIBIOTARSAL ANKYLOSIS

We shall be very brief in this last chapter. We may have no exact idea what arthroplasty will accomplish in a case of tibiotarsal ankylosis, as the number of cases actually published is small, but we have, on the other hand, a rather distinct opinion that a modeling resection of the ankle, which often means merely an astragalectomy, gives satisfactory results. The recent discussions of the Paris Surgical Society on the treatment of vicious callus at the ankle, the reports of Bérard and Wiart at the twenty-ninth French Congress of Surgery have shown that astragalectomy is indicated in a good number of vicious ankyloses of the ankle; the operation frequently not only gives an opportunity to straighten up the foot and give the joint proper orientation but also results in movements which though limited in range are none the less useful. Astragalectomy is not always the easiest thing to do in such a case. One great danger arises when the bone is fused with the bones of the leg over a wide area. The most frequent indication is the correction of the vicious position; the attempt at movement is only secondary. Ollier has already advised that in such a case removal of the astragalus *in situ* by a modeling resection and chipping away with a chisel should take the place of the old cuneiform excision because the ideal operation in a case of this kind is one which aims at reconstructing if possible an ankle mortise which guarantees stability for any result obtained.

For the ankle, as for all other joints studied, the postoperative care is as important as the operation itself.

We wish to reiterate that in ankylosis of the ankle our aim should be first of all to secure a solid and well oriented joint. Prolonged immobilization must then be the rule when lateral and anteroposterior fixation is to be secured; then only intervenes the possibility of movements of flexion and extension which are quite frequently very satisfactory.

We shall not discuss the simple cases where the tibiotarsal ankylosis has not altered the form and the mutual relations of the bones, as in such cases astragalectomy is customarily indicated, and the results obtained justify its use.

CONCLUSIONS

The following conclusions may be made from this study:

Arthroplasty enlarges considerably the field of operation for ankylosis. In the hip and knee arthroplasty opens up almost a virgin field in joint surgery.

Resection for ankylosis becomes a secondary method to be used only after failures by arthroplasty or in those cases in which the condition of the bones of the joint, or more rarely the condition of the soft parts, makes mobilization a hopeless procedure.

SEROTHERAPY AND VACCINOTHERAPY IN SURGICAL INFECTIONS[1]

By Dr. LOUIS BAZY, Paris, France
Surgeon, Paris Hospitals

TO treat in its entirety the question of serotherapy and vaccinotherapy in surgical infections would greatly exceed the time allotted me. The subject itself urges me to confine my discussion to very general ideas. The particular applications of most of the serums and vaccines have already been presented at various congresses for general or special surgery, but it remains the duty of each of us to report the results of our own personal experience. To try to conceal from oneself the facts that the study of vaccines and serums, which is in reality the study of immunity and immunization, bristles with difficulties, that it is still shrouded in mystery, and that it cannot be undertaken with too great circumspection would be useless, for the risk is great that the truths of today will not be the truths of tomorrow. It is for these reasons that I believe it will be best to forego the analysis of particular cases. Such analysis might increase the already existing confusion and thus lay myself open to most humiliating contradictions by future surgeons. I shall therefore present first a methodical study of the sum total of our present knowledge, and then endeavor:

To define with the prudence demanded in such cases, the ground already acquired;

To determine the rôle which serotherapy and vaccinotherapy appear to hold in relation to surgery and the degree in which they appear susceptible of modifying the surgeon's acts;

To form an estimate of what one may expect from these methods in the future, which in the end means the establishing of a program of association between biology and surgery.

The General Action of Serums and Vaccines—Paraspecific Action

colloidal shock (widal)—peptonic action (nolf)

At the foundation of the therapeutic use of serums and vaccines lies the idea of specificity. Nevertheless, for many years none of those who have employed vaccinotherapy and serotherapy in human as well as in veterinary medicine, has failed to remark that these therapeutic measures have been successful in cases where the idea of specificity could in no way enter. What analogy is it possible to establish between two bodies as different *a priori* as a serum and a micro-organism except the analogy of their chemical constitution? Both are albuminoids, or, if one prefers, belong to the group of proteins. The fact is that it has been possible to influence the course of all sorts of infection by injecting into the organism any kind of protein whatever, milk or peptone, for example; in other words, in certain cases, vaccinotherapy and serotherapy are only forms of proteintherapy.

On the other hand, the physiologist Schmidt-Muehlheim long ago showed that the introduction of peptone into the veins produces certain effects which have been termed "peptonic shock." Many other experimenters have studied this phenomenon, and credit is due to Delezenne, in particular, for showing that a great number of other substances, such as microbic toxins, vegetable and animal poisons, and extracts of organs, are equally capable of producing as much shock as peptone. In fact one may affirm in principle that all substances possessing antigenic qualities, that is all foreign proteins in normal humoral medium, produce it. From the researches of Nolf it appears that a smaller dose eliminates the danger of peptonic shock — in its extreme form a brutal and injurious reaction, which follows the rapid introduction of too large a dose of peptone into the blood stream —and produces the "peptonic action"—the expression of a beneficial reaction. Such a dose is suitable for therapeutic use. The practical results obtained by Nolf with this method, particularly in the treatment of surgical septicæmias, are known. "But there is also a theoretical advantage gained by the

[1] Presented before the International Congress of Surgery, London, July 16–21, 1923.

introduction into therapeutics of intravenous injections of peptone. It has made us realize that, in the matters of serotherapy and vaccinotherapy, our ideas have been too simple, and that when we inject a serum or a vaccine into a patient the effect we obtain may be produced by other means than the specific antibodies which we introduce or cause to be formed. We now know that these agents produce, aside from their specific action, the peptonic action and that this is capable of curing even serious conditions." (P. Nolf.)

This is not the only idea on the subject to which the last few years has given birth. Since 1913, M. Widal and his pupils, P. Abrami and Étienne Brissaud, in a long series of reports have shown the importance of the colloidal reactions which may take place in plasma and which they term "*hæmoclasic crisis*," or "*colloidal shock*." In particular they believe that, in serotherapy and vaccinotherapy, certain immediate successes attributed to the specific action of the serums or vaccines are in reality caused by the reaction of protein shock which the presence of any foreign protein in the organism may produce. To sum up, it is not the substance injected which is the real curative agent, it is the shock provoked by the injection. So true is this that to complete the formula which we have given above, we must say: in certain cases, serotherapy and vaccinotherapy, like all protein therapies, are only forms of colloidal therapy.

THE THEORY OF SPECIFICITY

The work of these different men has broadened our ideas. It has drawn our attention to a series of phenomena the knowledge of which is of the greatest interest and utility. But it should not obscure for us the fact that the real importance of the idea of specificity must be grasped before we can hope to attain the true goal of serotherapy and vaccinotherapy, i.e., not to produce cures that can just as well be secured by other means, but to produce immunity. Immunity and specificity are inseparable terms, and to avoid the risk of serious miscalculations in the use of serotherapy and vaccinotherapy and to avoid failures in using these two methods, one cannot too often repeat that, in the present state of our knowledge, a real, durable immunity cannot be produced except by specific intervention. Specificity is the foundation of all our biological researches. I will cite a recent example. My preceptor and friend, Professor Vallée, with whom I have the very great privilege to work, has just introduced into the study of aphthous fever the idea of the plurality of viruses. How did he discover this and how could he demonstrate it? By the same series of classic experiments which have been used so many times by which it was possible to prove that by the side of typhus bacillus there were the paratyphus bacillus and by the side of the meningococcus the parameningococcus, etc.; that a patient who had suffered from a disease produced by a determined germ had in consequence resistance to that germ only, that preventive vaccination, like preventive serotherapy, conferred only a narrowly specific protection, and that it was, this peculiarity which was found at the starting point of the work of identification of the different viruses.

Further, M. Widal, having shown that to his mind the immediate effect of vaccines is explained not by a specific action, but by a colloidal shock, declares: "The employment of a specific vaccine has this undeniable advantage, that to the primary action, of which, as we have seen, the therapeutic effect is uncertain, there may be added a secondary action set up in the organism by the introduction of the antigen responsible for the disease." The same opinion is expressed by Nolf.

I believed it necessary to insist on these points. Because it has been demonstrated that serums and vaccines may have other than their specific actions, it might be concluded that it is no longer necessary always to pay so strict attention to the findings on which their employment rests. That unfortunate tendency has given rise to a great number of useless observations in the medical literature. Today, before we express our opinion on the treatment of cancer, we demand a detailed and competent histological examination; to form an opinion on the results produced by a given serum in a given disease, we must refer to the results of the bacteriological test.

The paraspecific use of serums and bacterial medicines none the less offers great conve-

niences to the surgeon. We are not acquainted with the germs of all diseases, either because they are as yet unknown, or because, as in certain walled-off infections, so frequent in surgery, they have escaped our investigations. We do not possess specific medication against all germs. In these circumstances serotherapy and vaccinotherapy, employed under the title of proteintherapy, render incontestible service, and it is with this consideration in view that M. Vallée and myself have been studying, since 1918, the microbic extracts to which we have given the general name "endococcine." These extracts appeared to us to possess the advantage over serums of not sensitizing the organism, and over vaccines of being products of more stable composition and of indefinite preservation, and over both of being more easily managed, since they possess a better titration and a composition always comparable to itself. In all cases where we possessed a specific medication we have found the employment of the endococcine useless or impossible. In this way we have obtained the most satisfactory results in a great number of infections differing widely as to seat and as to origin. These cases were presented in two reports, one to the Academie des Sciences on June 7, 1920, the other to the Société de Chirurgie de Paris, May 10, 1921.

Passive Immunization, Serotherapy

Serotherapy rests upon the demonstrated fact that by injecting into a patient the blood serum of another patient, naturally or artificially immunized against a disease, one transmits to the former the immunity enjoyed by the latter. The former receives the antibodies necessary for its defense which have been elaborated by another organism. It has had no share in the effort to produce them. Otherwise expressed, it accepts passively the immunity given it by another. The usefulness and indications of serotherapy may very nearly be deduced from these principles.

A certain number of serums may be used by the surgeon. They are very unequal in value.

In addition to antitetanic serum, the study of which does not come within the limits of this report, the war of 1914–18 showed the importance of antigangrenous serums. Certain explanations are necessary concerning them, for their study constitutes one of the most complex chapters in serotherapy, and one could not choose a better example to demonstrate the value of using strict scientific methods to get the greatest benefit from a wonderful therapeutic measure. It cannot be said that antigangrenous serotherapy always has been employed with understanding. It must be remembered, when one speaks of gangrene, or of gas gangrene, one means a symptom only, a symptom which is common to many diseases and very different germs. There is not one gangrene, but many gangrenes. It is impossible to differentiate them clinically, and when the symptomatic picture is complete, local phenomena (necrosis of the tissues, production of gas) and general phenomena due to poisoning of the central nervous system by the toxins generated by the microbes are present. Three principal germs were isolated from war wounds: the bacillus perfringens, the septic vibrio, and the bacillus œdematis described by Weinberg, which appears to be the germ described by Sacquépée under the name bacillus bellonensis. Each of these three germs may be found alone in the wound, or they may co-exist. They are frequently associated with other germs, the common pyogenic germs, in particular the streptococcus, which encourage their pathogenic activity. I have often seen the streptococcus, especially in its anaerobic variety, existing alone in a wound causing necrosis with local gas production and general toxæmia.

Serums have been prepared with all these different germs. Each is capable of acting efficaciously against the corresponding germ and against that one only. How is one to select the proper serum? We know with what rapidity gas gangrene septicæmia may develop from certain wounds. Haste is therefore necessary in the endeavor to prevent its appearance. To inject one only of these serums may prove of no use at all. To inject them all is a complicated procedure and makes it necessary to give a wholly disproportionate dose. The true solution has been found by Leclainche and Vallée, who, in producing their polyvalent serum are the actual

initiators of antigangrene therapy. It is curious to note that this perfect solution is the first in point of time, it was Leclainche and Vallée who inspired me to use a serum valent for all the pyogenic organisms and the perfringens and septic vibrio, which I did from November, 1914, on. One copious injection, made as soon as possible after infection of the wound and renewed at intervals as necessary, assures protection not only against the germs productive of gangrenous septicæmia, but also against the associated germs which are of such great importance. Have we not seen wounded succumb to streptococcæmia, who, thanks to a serum, had escaped the grave dangers of gangrene? For the surgeon this serum represents the ideal product, which does away with tentative measures and gives him a quasi-certainty that it will meet the situation. In medicine is one not guided by analogous principles in cerebrospinal meningitis? The first antimeningococcic injection is made with the trivalent serum, the necessity of which has been proved by recent researches. Later, when the causal germ has been identified in the laboratory, a less general, more directly specific, serotherapy can be used.

Their serum presented such simplicity of application that we regret that Leclainche and Vallée have now restricted its action to combatting the pyogenic organisms only. The Pasteur Institute of Paris furnishes excellent serums, directed, respectively, against the bacillus perfringens, the septic vibrio, and the bacillus œdematis. But I know, from having heard it so many times on occasions when my advice has been sought, that, confronted with this multiplicity of serums, the practitioner finds himself in a cruel embarrassment, not knowing to which he should have recourse. One can only reply as follows:

Numerous failures of antigangrenous serotherapy are explainable on the ground that the serum appropriate to the case was not used. They are again explainable by the fact that beside the gangrenous septicæmias that have their origin in the wounds, there exist other phenomena, also termed gangrenous, which have no causal analogy to the preceding.

It is thus, for example, that the terms pulmonary gangrene and appendicular gangrene give rise in many minds to the idea that the same germs that cause gangrene in wounds are responsible for these two processes. But, save in rare exceptions, they are not. Most often these diseases are produced by very numerous anaerobic germs living nearly always in symbiosis, which have been particularly well studied by Veillon, Zuber, and Guillemot, germs against which, unhappily, attempts to prepare an active serum have to the present time remained unfruitful. This has not hindered a large number of investigators from attempting to combat these infections by antigangrenous serums commonly in use, by means of general injections, or, in case of pulmonary gangrene, by tracheal injections. The results have been variable. Successes have been observed that cannot be explained except by the paraspecific properties of the serums employed, and failures that were due only to the absence of specificity. This brings us back to the statement that serotherapy must be guided by a rigorous bacteriologic control, and that, to demonstrate this anew, one could not choose a more complete and instructive example than that of antigangrenous serotherapy. It is for this reason that we have lingered a little upon it, but also because of its practical importance, which, for surgery, remains in time of peace very much what it was in time of war.

There are still other serums which present themselves to the attention of the surgeon. I do not speak of the antistaphylococcic serotherapy, which, used alone, is not adapted to frequent applications. Antistreptococcic serotherapy, in spite of all the disappointments it has caused, is of much greater value. It is possible that a part of the inconstancy of the results which it has shown may be due to defects in the technique of its preparation. Investigators are now striving for improvements in this particular. One of the most powerful antistreptococcic serums is that of Leclainche and Vallée, which possesses, among other things, the advantage of being polyvalent and attacking all the pyogenic micro-organisms.

Since 1897 endeavors have been made, with variable success, to prepare a good antigonococcic serum. In France, since 1913, Debré and Paraf have attempted to solve this prob-

lem. At the present time these authors, whose studies were interrupted by the war, employ the serum prepared by the Pasteur Institute of Paris by Professor Maurice Nicolle, the use of which is very widespread.

Finally one must not forget the antituberculous serums, the best known of which, in France, are those of Vallée and of Jousset. The latter is at the present time the only serum with which one can experiment practically, M. Vallée having, provisionally at least, given up his researches on this point.

In the present state of things, what success may one look for in practice from the use of these different serums? Results are unavoidably very inconstant. The reason lies in the very nature of serotherapy and in the inherent difficulties attending the preparation of a good serum.

By the introduction of the fully prepared antibodies, the serum injection aids the organism in its struggle against the infection. But it is necessary that the organism possess a minimum of the resistance required to profit by the reinforcement brought to it; in other words, that it should not content itself with the passive immunity conferred upon it by the serum, but should make active efforts to establish its own protection.

It is necessary to note also that the antistreptococcic, antituberculous, and antigonococcic serotherapy are directed against germs of a particular resistance. One may form some idea of the magnitude of the task which we demand of the different serums, when we consider the means of defense at the disposition of the microbes they must attack, which permits these to live, without becoming absorbed, in the interior of the leucocytes, the digestive action of which they succeed in escaping.

If we take for example the gonococcus, we may be met by an objection which Bordet, in his treatise on immunity, has taken pains to formulate: "One has attempted to apply serotherapy to diverse diseases to which our species is liable, and the results have been very unequal. One is often astonished, in the course of similar attempts, at the inefficacy of certain serums which nevertheless have proved themselves distinctly preventive, or even visibly curative, when administered to animals which, by inoculation with the variety under consideration, have developed one of these artificial diseases, one of these laboratory infections, such as typhus septicæmia." One has then the right to inquire what may be the value of these serums, produced by laboratory infections, on animals less sensitive.

One can even conceive, on the other hand, that it may be difficult to confer a passive immunity in those diseases that do not permit of an active immunity, which is unhappily the case with the streptococcus and gonococcus infections, tuberculosis, and syphilis.[1]

Finally, account must be taken of the fact that the principles contained in the serum afford us a very incomplete view into all that is necessary for the protection of the organism. With special reference to tuberculosis, note the following which was written by Calmette in his splendid treatise on bacillary infection and tuberculosis (*Traité de l'Infection bacillaire et la Tuberculose*): "It is generally admitted that there exists a sort of parallelism between the richness in antibodies of an animal serum or a tuberculous patient, and the activity of the means of defense of the same against bacillary infection. It would seem that this hypothesis is not strictly correct, for it frequently occurs that the development of the lesions continues even where the antibodies are very abundant. The fact that these disappear toward the end of the disease and that most often their rate increases in proportion to the intensity of the efforts of the organism in its struggle indicates that they appear rather as witnesses of cellular reactions against the infection. But that is sufficient to justify their investigation and incite us to the discovery of the proper means of augmenting their production." (p. 548.)

M. Calmette again writes: "In endeavoring to treat diseases by the injection of serum more or less rich in antibodies, agglutinins, precipitins, etc., we are probably making absolutely vain efforts; for as rich as the best serums known today may be in these various substances, in the doses in which they are in-

[1] It must, however, be observed that, as concerns tuberculosis and syphilis, the idea of the non-existence of an active immunity does not imply a total failure of the organic defenses. In these two diseases, in fact, we may note the insusceptibility to reinfection, which disappears, as in the case of syphilis, when the disease is cured.

jected, they add almost nothing to the quantities, normally considerable, of antibodies, agglutinins, etc., that are contained in the blood of the patients themselves." (p. 565.)

Still other reasons tend to limit the value of these injections of therapeutic serums. When a serum is introduced subcutaneously, which is the most common because the easiest and least dangerous manner, it should be noted that a certain quantity of useful antibodies is retained at the point of inoculation by virtue of that principle demonstrated by Vallée and Finzi, which may be termed "local fixation of the antibodies." Inspired by the work of Vallée and Finzi I brought to the notice of the Surgical Society in 1917 the importance of this idea to the surgeon. It was my habit to make interstitial injections of antigangrenous serum in the immediate vicinity of war wounds, with the object of uniting the general and local effects of serotherapy.

It is, on the other hand, thoroughly demonstrated, that a serum introduced into the general circulation can only with great difficulty reach certain fluids, such as the aqueous humor and the cerebrospinal fluid. The same may be said of the pathological fluids which are produced, in the case of infections, in the synovial membranes of joints.

LOCAL SEROTHERAPY

All these facts would be, to speak truly, discouraging enough, were it not possible to extract from them practical conclusions for the surgeon. Many of the infections which surgery has to combat are, if not local infections, at least infections with localizations. Since serotherapy for the moment is dashing itself against impossibilities and thus detracting from its success, would it not be possible to concentrate its undeniable benefits on those points where its necessity has been felt? In fact, the serums which, introduced into the general circulation, yield inconstant or doubtful results, may in local applications give a large proportion of successes.

Such is the basis of local serotherapy. Denys and Leclef have shown that leucocytes isolated from the blood of an animal vaccinated against the streptococcus do not seize upon the microbe with more avidity than leucocytes from an animal not so treated. But whatever may be the source of the leucocytes, the addition of an immune serum re-enforces in the same measure the phagocytic activity which is but feebly increased in the presence of a normal serum. On the other hand, it is easy to demonstrate experimentally that the serum does not act on the cell to make it a more powerful phagocyte but upon the microbe to make it a less rebellious prey. How does the presence of the serum render the microbe more vulnerable? The microbe becomes coated over, as with a dye, with the substances which favor its destruction. It charges itself with the very ferments of immunity. It absorbs the sensitizer. I would insist upon this point. The characteristic is not that the germ can be more or less readily phagocytosed but that it succumbs to intracellular digestion, in a word that it is destroyed. Many substances favor the phagocytosis. The antibodies alone permit it to be completed by intracellular digestion, which represents organic defense carried to its maximum of efficacy.

One cannot too forcibly call attention to the importance of the local application of serum. Up to the present time we have been almost too exclusively devoted to general effects, specific or otherwise. Thus we have not obtained from serotherapy all the benefits it is possible to obtain with it. I repeat that a serum which gives negative results when introduced into the general circulation has a local effect, produced by the antibodies which it contains and which by elective action fasten upon the germs rendering them vulnerable. There will not be found a better example than that of the antirabic serum, which has no curative or preventive power but which, brought into the presence of the virus, entirely neutralizes it.

Different applications of local serotherapy have sprung from these principles, still too little known. In 1912 Leclainche and Vallée recommended specific serum treatment of wounds by means of their polyvalent serum. I had the honor to be associated with them in their clinical investigation from the beginning, and their method, which I had very extensive opportunity to employ during the war, gave

me, as it did all other surgeons who used it, incontestable successes.

In 1919 Debré and Paraf described the treatment of gonorrhœal rheumatism by local injections of antigonococcic serum. Paraf in his thesis (Antigonococcic Serotherapy, Paris, 1919) reports 16 cases treated, with 14 complete cures obtained. I myself discussed this interesting method of treatment before the Surgical Society of Paris (March 16, 1921, p. 390), and later other conclusive cases were reported before the same society, notably by Mm. Auvray and Michon. Personally I have applied local intra-articular serotherapy to certain forms of tuberculous synovitis known under the name of tuberculous hydrops. I have cured several patients of that affection. One of them was brought before the Surgical Society on January 25, 1922 (p. 116). The antituberculous serum which I used in all these cases was furnished by M. Vallée. M. Jousset told me that he also tried this treatment on one occasion, but with a serum that he had himself prepared. In a bacillary hydarthrosis that had been treated by means of several punctures which were followed by immediate relapses, Jousset did one injection of this serum with the result that in a few days the hydarthrosis had dried up, not, however, without there having taken place a violent reaction lasting 36 hours.

I also had occasion in the course of the war to practice intraspinal injections of Leclainche and Vallée's polyvalent serum for traumatic meningitis. Philibert obtained cures in three cases of suppurative streptococcic meningitis by injecting antistreptococcic serum into the spinal canal.

Local applications of serotherapy are thus seen to possess for the surgeon the highest possible importance. Instead of taking up the ofttimes illusory research into general effects, he should direct his efforts toward the utilization of the local neutralizing properties of serums.

ADVANTAGES AND DISADVANTAGES OF SEROTHERAPY

Specific serotherapy in producing in the organism a passive immunity possesses the double advantage of acting very rapidly and of demanding no effort on the part of the organism. For this reason it is valuable. It is the heroic remedy, the remedy for critical cases.

On the other hand, these advantages are compensated for by a certain number of disadvantages. In human medicine the serums are all derived from the horse. The serous albumin which serves as support and carrier of the antibodies belongs to a foreign species and hence tends to be quickly eliminated by the emunctories of the organism, taking the antibodies with it. In order that the value of the passive immunization conferred by the serum shall not fall too rapidly, it is necessary, where a durable immunity is desired, to renew the injections. Now what is the effect of repeated doses?

a. An organic defense exerted against the foreign albumin of the serum and at the same time against the antibodies which it contains. The action against the foreign albumin produces the general serous symptoms, and they are too well known to need mention here, and the symptoms of local intolerance in the presence of serums, which is less often spoken of but of which it is important to be warned. Everyone knows that in cerebrospinal meningitis the intolerance of the meninges to serous injections often impedes the continuance of the treatment, or in any case indicates that it should be stopped. I have myself observed serous arthritis secondary to intra-articular injections of serum, and have drawn the attention of surgeons to it, and to the necessity, in certain cases where it is found, of not overprolonging the specific serous treatment of wounds, which at a certain point, may become more injurious than helpful.

Bordet has shown that there is also a reaction against the antibodies, and he has made us acquainted with anti-alexins, anti-agglutinins, anti-sensitizers. Other authors (Dehne and Hamburger, Gay, Vallée and Finzi) have disclosed the existence of an anti-antitoxic function. All these discoveries point to the fact that at each fresh injection the serum is less and less utilized and its action is less and less certain.

b. If the human organism defends itself against the different elements carried by the

serum, the germ of the disease, itself a living entity, if it has not succumbed at first, prepares, on its side, a system of resistance. In experimenting on the streptococcus, Bordet has been able to prove that certain microorganisms, engulfed by the leucocytes, have been enabled to escape from the destructive influences that attacked them, "they awaken, multiply, and give birth to entities endowed with very pronounced virulent qualities of normal appearance and dimensions, but surrounded by a strong protective capsule." That sheath, that areola which protects the streptococcus, is transmitted to its progeny.

FAILURES OF SEROTHERAPY

We have enumerated all these experimental facts only because they make it possible for us to understand the failures of serotherapy and consequently to endeavor as far as possible to avoid them.

A serum may give no result—

1. Because one has chosen a serum that is non-specific, the serum may be prepared for a germ of another species; or if for one of the same species the important principle of the plurality of races, each possessing its own specificity, has been misunderstood.

2. Because one has given too weak a dose. It may be supposed that when the serum spreads throughout the organism it undergoes great dilution which brings about a lowering of concentration of the active substances which it contains and in consequence a great diminution in their activity, which might extend to their annulment.

3. Because action was too long delayed. From numerous experiments with all sorts of germs and serums, it has been shown that the protection offered by these latter increases in inverse proportion to the time that elapses between the entrance of the virus into the organism and the introduction of the serum into the organism. Practically this is all that constitutes the superiority of preventive serotherapy over curative serotherapy.

4. Because one has selected a wrong route by which to introduce the serum. We have just shown that a serum introduced into the circulation reaches certain organs in negligible quantities. It is, therefore, illogical to treat local infections of these organs by general injections of serum, which in such cases are of no advantage except as an adjuvant of the local serotherapy to combat general symptoms, to prevent other localizations and above all to arrest the too rapid elimination of the serum deposited *in situ*.

As for general serotherapy, all the authors (S. Arloing, Calmette, Salimbeni, Vaillard, and Dopter) are agreed in attributing great importance to the route by which the serum is introduced. By means of tuberculous serum endowed with precipitation properties in the presence of tuberculin, Vallée and Finzi have proved that—

1. During the first few hours after the injection of serum, the recovered serums which were richest in antibodies were those of the animals treated by the venous route; there follow, in order of decreasing activity, those of the animals treated by the peritoneal route and rabbits injected subcutaneously.

These differences registered in the precipitation value of the serums recovered from the various animals may also be set down in figures. The serum of rabbits treated by the venous route precipitates at the rate of 1 to 100 (1 of serum to 99 of antigen), that of animals injected by the serous route furnish a precipitate equal only to 1 to 50 and that of rabbits treated hypodermically yield the equivalent of 1 to 10.

2. "Examining next the fate of antibodies introduced by the different routes, and the progress of their elimination by the organism, we found that at the end of 21 days the precipitation value of the serum of rabbits treated by one or the other method has become the same, and that on the twenty-seventh day of the experiment the serum of the rabbits treated by the various routes has lost all its activity, while those animals which received their serum at the same time as these, either by the peritoneum or subcutaneously, were still distinctly precipitating demonstrable antigens. The precipitating aptitude of the serum of rabbits injected into the peritoneum ceased to be discernible after 28 to 32 days; that of animals injected subcutaneously preserved precipitating qualities 32 to 38 days according to the weight of the rabbits.

PRACTICAL CONCLUSIONS

From all that we have been explaining it follows that to derive from serotherapy its maximum of efficacy it is necessary:

To act early. An antitoxic serum has no action upon toxins lodged in the nervous centers.

To administer strong doses from the first. This is the best means of strangling an infection and of avoiding those curious cases of microbic adaptation by which a patient attacked by streptococcic septicæmia may, thanks to the serum, and contrary to all expectations, escape the immediate death that menaced him, but in the end succumb to multiple localizations.

To repeat the injections, when a durable immunity is required.

To give the serum locally whenever possible.

To use the venous route when quick action is important, which is the case in curative serotherapy.

To have recourse to the intramuscular or subcutaneous route if it is necessary to obtain prolonged action by the *preventive serotherapies.*

That serotherapy should not be used:

1. In chronic diseases, except to suppress a threatened acute attack or where a rapid local result may be hoped for. This is the case in antituberculous serotherapy.

2. Or in diseases in which the danger may increase slowly; for this reason M. Vallée and I substituted antitetanic vaccination for serotherapy in those patients whose wounds healed slowly, or who still retained foreign bodies which had been impossible to extract.

That a serum should be regarded as a remedy to be used only in critical conditions and never without careful consideration. M. Marfan has protested against the abuse of serums used without discrimination for the treatment of hæmorrhages, acute non-diphtheritic tonsillitis, erysipelas, anæmia, pneumonia, etc. "The therapeutic results of such employment seem hardly favorable. It would be better to refrain from using them so that the patient will not be in a state of anaphylaxis, that is to say, in a state of lowered resistance at a time when he shall have real need of specific serotherapy." Bordet also has declared: "In human therapeutics it is wiser to abstain from using, at least as a routine measure, those injections of a horse serum sometimes recommended for the treatment of morbid conditions of little danger, so that if the organism is attacked by some grave disorder, such as diphtheria which is amenable to serotherapy, it will not find itself prepared to combat the valuable antibodies elaborated by the horse."

We ought to be much more concerned about the existence of an antiserum function in persons who have previously received injections of serum, than about the dangers of anaphylaxis. To speak truly, these dangers are very rare, and there are many effective and simple means of avoiding them, whereas we can do nothing against the formation of antiserums which are certain to result in imperfect utilization, or no utilization at all, of a serum injected later.

Consequently, in all cases where they are not strictly useful, serums should not be used. This applies particularly to all cases where it is possible to use instead active immunization by means of vaccination.

ACTIVE IMMUNIZATION—VACCINATION

"To put the organism artificially in a state comparable to that in which it would be if it were cured of a spontaneous attack of a disease under consideration is the object of active immunization or vaccination." (Bordet.)

It will be seen that this definition implies the idea of specificity. We shall not speak further of the paraspecific effects of the vaccines which we studied in the beginning and which are common to all other products as well as the microbic. Here it will, perhaps, be well to settle the terminology. The use of vaccines, without taking account of their specific properties is, properly speaking, bacteriotherapy. When they are employed to bring about specific actions, they may be used preventatively, to preserve the organism from the attack of a disease, in which case we speak of vaccination. Or, again, the vaccine may be used to cure an infection in the state of development, and the term then applied is vaccinotherapy by which is indicated a specific bacteriotherapy.

In surgery, however, one very seldom has occasion to use true vaccination. The infection has usually declared itself. But it is important to explain that, since the surgical infections which are most amenable to treatment by vaccines are either diseases that evince a great tendency to relapse, such as streptococcic infection, or those, such as inflammations of the urinary passage, which are produced by germs usually saprophytes, that have become pathogenic, the administration of a vaccine has in reality the double object of curing the disease in its course and of preventing relapses or the return of the saprophyte to the pathogenic state. Thus the surgeon in his ordinary practice simultaneously obtains from vaccinotherapy and vaccination, prophylaxis and a cure.

JUSTIFICATION OF INJECTIONS OF VACCINE

One may inquire the basis upon which rests the injection of microbic bodies in an existing infection. It may seem strange that the organism in which the living germs are developing, which represents *a priori* the best antigen, and which, nevertheless, has not succeeded in immunizing itself, can be benefited by introducing dead microbes. But justification of method will be seen if it is recalled that—

1. A local infection confers no general immunity. "The germs which vegetate in circumscribed areas of the organism and maintain their hold there with tenacity, though in limited numbers, do not come into sufficiently extended contact with the agents of defense. Phagocytosis especially does not exert its influence widely enough, hence absorption is not sufficiently elicited." (Bordet). They produce the phenomena of local immunity but not of general immunity.

2. The germs prepared for use in vaccines are more easily reached by the agents of defense than are those which have multiplied in the tissues. A germ which is not absorbed cannot excite the formation of antibodies. The tendency shown by certain surgical infections to become chronic and to recur is due to persistence of microbes, which have not been digested by the cells. It is for these diseases that an endeavor should be made to obtain efficacious vaccines.

At present the list of vaccines that have stood the test of experience and give sufficiently constant results is not long. The good vaccines employed in surgery are only two: (1) staphylococcus vaccine, which is intended for all staphylococcic infections, furuncles, anthrax, abscess of breast, and acute and chronic osteomyelitis; (2) vaccine for urinary infections produced, especially, by the colon bacillus, alone or associated with the enterococcus, micrococcus tetragenus, etc. Other vaccines have been proposed.

The streptococcus and gonococcus vaccines have given less conclusive results than have the two mentioned.

Various vaccines for tuberculosis are also being studied. M. Jousset employs an avirulent, soluble product, an extract of highly toxogenous bacilli. At the price of very strong but temporary reactions he has obtained some beautiful results in adenopathic fistulæ, cutaneous gummata, visceral suppurations, such as infections of the prostate and adnexa, and especially in those cases in which there is as yet no necrosis of the tissues but only an inflammatory hypertrophy, as in many of the tuberculous adenitides. Judgment cannot yet be passed on these results which represent only attempts. I have cured fistulæ following tuberculous lesions by attacking only the germs of the secondary affection, and, on using "endococcine." I have in a like manner seen ganglionic lesions recede. The work of M. Jousset who carries such scientific precision into all he does, should be followed with attention.

GENERAL INDICATIONS FOR VACCINES

From what we now know it would seem that vaccines have a double action—

A primary action, almost immediate (colloidal shock, peptonic action) due to their physicochemical constitution;

A secondary, truly vaccine action which demands that the natural defensive reactions of the organism be brought into play and consequently requires a certain amount of time for its manifestation.

It is, therefore, logical to apply vaccination only to those infections which are acute and present but moderate tendency to becoming

generalized. The fact that vaccination, contrary to serotherapy, demands an effort of the organism might give rise to the fear that while the organism was drawing on its energy to absorb the vaccine, the germs of the infection would profit by the diversion thus created to extend their activities. Wright has shown that every vaccination commences by creating what he terms the "negative phase." The reality of this negative phase has been doubted. Numerous experiments, however, as also clinical observations, in human as well as in veterinary medicine, tend to demonstrate it. I believe that until we have more information it will be prudent to take it into account.

It would be better to abstain from throwing too great a burden on the patient with severe infection, who, as it is, has difficulty in keeping up the struggle. In grave, acute infections, serotherapy is more suitable. We will return to this point later.

On the other hand, should vaccination be employed in infections that have passed into the chronic stage? In regard to osteomyelitis certain authors have replied categorically in the negative. If they mean that surgical treatment alone can cure a central bone abscess or remove sequestra, I agree with them. But I must say that in many cases where the roentgen picture reveals no localized lesion upon which to operate, where the disease manifests itself only by pain and fugitive inflammatory symptoms and disappears spontaneously after a greater or less lapse of time, resting latent over a variable period, then suddenly announcing itself in fresh attacks, I find myself much inclined to vaccinate repeatedly at regular intervals. It seems possible by this means to keep imperfectly extinguished foci in a torpid condition and avoid their flaring up. It is possible that in the end they would be entirely sterilized. Be that as it may, in the case of a woman previously operated on for osteomyelitis of the tibia, who had an abscess of the calf of the leg the size of a fist, I saw the abscess, which at the beginning of treatment contained a great number of staphylococci, both albus and aureus, become progressively aseptic under vaccine treatment, and as, at the same time, it had become surrounded by a thick fibrous capsule, I was able to remove it like a cyst and obtain closure of the wound by primary intention.

Another proof of the importance of vaccination in chronic cases is furnished by the study of gonococcic infection. It is generally admitted that gonococcus vaccination fails to influence acute cases except in a very uncertain manner. On the contrary it is often decidedly efficacious against the sequelæ of the infection. I have seen it succeed in prostatic infections that were resistant to local treatment, however well carried out.

The mechanism of the action of the vaccine in such cases has not been completely elucidated. But should we not here recall how Wright understood the action of vaccination? "Therapeutic immunization is theoretically admissible so long as there remains in the body a part that does not give its maximum reaction to the immunization; and the program of therapeutic inoculation would consist naturally in exploiting, in the interests of the infected parts of the body, the immunizing reactions of the parts not infected."

This is why it seems to me that vaccination may render good service in osteomyelitis or gonorrhœa, diseases which, passing into a chronic state, cease to be general and become purely local.

VACCINE REACTIONS

The introduction of a vaccine into the organism elicits local and general reactions.

A. *Local reactions.* (a) *On the lesion.—Focal flare-up.* One of the first effects of vaccines in most cases is that they appear to produce an aggravation of the symptoms. The flare-up of the focus shows that there exists a negative phase, during which the germs possess an increased virulence. But it must be remembered that the turgescence of the local lesions and the increase of purulent discharges are due, besides, to a very salutary excitation of leucocytic action. The focal reaction may also be compared with what takes place in preexistent foci when the "phenomenon of Koch" is produced at the point of reinjection. The vaccine, as in tuberculosis, produces a truly expulsive phenomenon, manifested, when there exist merely congestive lesions, by the rapid disappearance of the locally amassed

germs, or, when there is already suppuration, by a more rapid disappearance of necrotic lesions.

(b) *At the point of inoculation.* The introduction of the vaccine frequently produces a reaction at the point of inoculation which appears as a bright red plaque, the skin being tense, hot and painful. This temporary reaction may be accompanied by an inflammation of the lymphatic glands and vessels.

In many patients an analogous, but less acute, reaction is produced, not at the site of the last injection but at that of a previous injection. I have often observed this phenomenon with which others, familiar to experimenters, may be compared. Thus for example, when epizootic lymphangitis of the horse is reproduced, the creation of a fresh lesion starts up a new life in the foci previously created. Thus again the oculo-reaction has been seen to revive on subcutaneous injection of tuberculin.

GENERAL REACTIONS

Often very violent general reactions accompanied by malaise, rigors, and high septic temperature variations are observed.

It has been asked if these reactions could not serve a diagnostic end. But the results obtained have been discordant and absolutely inconstant. I do not believe that vaccine reactions can, at the present time, serve as evidence to the presence of the germ. They reveal only the sensitiveness of the organism to a given germ. From this point of view alone they may, as we shall see, render valuable service to the surgeon. One fact is very striking. Speaking of the use of Delbet's vaccine, M. Ombredanne pointed out that the reaction following injection of vaccine often fails to appear in children, whereas in adults it is the rule. I believe this difference can be explained on the ground that the pathological past of children is far less heavily charged than that of adults, and that they have not yet been submitted to all those influences that modify humoral equilibrium and the harmony of the means of natural defense. This opinion seems to me to be in accord with what we have learned of the reactions to tuberculin and, more recently, to diphtheritic toxin.

RESULTS OF VACCINATION

In fortunate cases, vaccination produces modifications in both the local and general conditions. It would seem useless to dwell upon these cures. But the manner in which they take place is important in order to judge of the value of the method.

When the lesions are local so that their development can be kept under constant observation, as is the case with furuncles, for example, one is struck by the fact that, in serious, rebellious forms, the disease does not disappear all at once. The present attack recedes, in general, rapidly before the influence of the vaccine. But another attack may supervene even before the first is entirely cured. In this case its activity is seen to be less. The furuncular microbes are rarer and smaller. Many do not result in suppuration. Each fresh attack thus is less severe than the preceding one, and in this we recognize the primary effect of vaccination, swift but fleeting, which supresses the present attack without preserving from those that follow, and the secondary effect, which is slower and which demonstrates the progressive resistance of the organism to the infection.

In other cases where there is frank suppuration, a change may be effected in the contents of the abscess, so that it no longer presents a tendency to spread and may be cured by an incision. As I have said, it is possible to render an abscess completely sterile, and in cases yet more favorable, on which it would be rash to build, to obtain even an absorption of the pus.

At the same time the general condition is improved. It is remarkable with what rapidity this happy condition frequently supervenes, even before the lesions are sufficiently altered to explain it. One might say that the organism which hitherto had been held in subjection to the infection, had now gained the upper hand. Under certain circumstances improvement in the general condition is the real benefit to be obtained from vaccination. This is the case, for example, in many infections of the urinary tract. I am speaking of the frequent colon-bacillus infections. Some are acute in their course and, it must be recognized, can be completely cured without vaccination; the cure can be verified by the dis-

appearance of both pus and microbes. But in other forms, of slow course, an ideal cure is more difficult to obtain. The pus disappears but the microbes persist. This accords with the discovery that certain persons are carriers of bacteria and that their urine contains undoubted colon bacilli. The germs live as saprophytes, awaiting only the occasion to awaken and become pathogenic. What is the aim of vaccination? To cause the microbe which has become pathogenic to return to its former condition of saprophyte. When this has been attained, when an equilibrium in favor of the organism has been re-established, the general condition improves, although, properly speaking, the word "cure" cannot be used here, for the microbe is always there, ready to profit by the least weakening of the defenses. M. Vincent has shown that the urine of patients thus treated by vaccination contains few antibodies, and by this he explains the difficulty found in curing such cases, in the exact sense of the word. I believe, nevertheless, as I have just said, that vaccination is useful. We all know that urinary infections have, from time to time, febrile flare-ups in the course of which culture of the blood is often positive. A good work might be done by increasing the quantity of the circulating antibodies.

I have witnessed true "paradoxical vaccinations." A man with a large vesical calculus had a severe urinary infection. With a view to preparing him for the necessary operation the patient was vaccinated. The general condition improved, the urine was found to be sterile. In a very aged woman both kidneys were filled with calculi. Surgical intervention did not seem permissible, and yet at nearly regular intervals she underwent violent attacks of urinary fever. It was conjectured that the febrile crises coincided with the periods when the natural immunity, which she was able to acquire, fell. An attempt was made to reinforce immunity by auto-vaccination. The febrile attacks did not reappear, in spite of the presence of the calculi, although germs were always present in the urine. It would seem that vaccination permitted the organism to keep the infection within limits where it would not be troublesome, etc.

DURATION OF THE IMMUNITY CONFERRED BY VACCINATION, REALITY OF THIS IMMUNITY

As I have insisted so often that vaccines which are suitable for surgical infections in which the tendency to relapse is only too certain, and which, furthermore, confer upon the body no natural immunity, are not so much curative as preventive vaccines, I would like to be able to make some definite statement as to the duration of the immunity conferred by vaccination. However, in spite of the great practical importance of the question, I am unable to do so.

The microbes from which vaccines are usually prepared for surgical uses are not what would be called good antigens. It follows that the experimental study of the immunizing properties is very difficult and of scarcely as much use as a guide to treatment as was the case in serotherapy.

On the other hand, even though we have cured a surgical infection we cannot infer that it is because we have produced phenomena of immunization in the organism. We all know that furuncles, erysipelas, and gonorrhœa are cured spontaneously, and, alas, we know also that a first attack is no protection against subsequent ones.

In some very rebellious infections, certain furunculoses, for example, which continue without intermission and in spite of all treatment up to the day of vaccination, one sometimes sees a sort of truce take place. Inasmuch as it was preceded by the phenomena of steadily progressive attenuation which we have described, and as the cure took place after various other forms of treatment had failed, it may be adjudged that the credit is due to the vaccination; consequently, to an immunization. But in these cases I have seen a fresh attack occur after the lapse of about 3 months. In the cases to which I allude, they were, it is true, less severe than the first attacks and usually they yielded more readily to the fresh series of vaccine injections with which they were combated.

It will be concluded that the immunity conferred was very fragile, since we were obliged to renew it by *revaccination*. But it is clear that the new series of vaccine injections had a more rapid effect than the first. We know that

patients previously vaccinated retain for a long time after their immunity has considerable diminished an extraordinary aptitude to reproduce antibodies when they are again called for. If it is desired to obtain as complete resistance as possible in a case of stubborn infection, I think that rather than carry out one very long series of vaccine injections, it would be better to give several series with periods of rest between. It seems to me that I have obtained the best results in this way. This accords with a remark often heard in the institutes of serotherapy. It is not possible by increasing the dosage of the inoculations to produce through the horse a serum which exceeds a certain strength. If instead of rushing blindly on in an attempt to increase the immunity given to the animal, the treatment is suspended for a certain time, when it is begun again the strength of the serum is seen to rise suddenly.

We have seen that the immunity to surgical infections conferred on man is of short duration and that it is so fragile that, to be preserved, it must be continued and we ask ourselves: Do we vaccinate, in the sense of immunization? A partial immunity is perhaps conferred, but we are free to doubt whether it is total. Contrary to what we have noted in the case of serotherapy, vaccinotherapy is more successful in the cure than in the prevention of disease.

Our inability to give information on these fundamental points, *the duration of the immunity* and *the best means of obtaining it* (choice, dosage, routes for introduction of vaccines) is because of the fact that at the present time we possess, aside from Wright's opsonic index, which shows only one of the aspects of the problem, no practical means of controlling vaccinations.

FAILURES OF VACCINATION

We will attempt to determine some of the causes for the failure of vaccination:

a. *Those depending upon the organism of the patient.* Some persons have difficulty in acquiring immunity. They present what is termed anergy. This anergy may be natural or connected with a condition or a disease. There is an *anergy of pregnancy*. While vaccination succeeds wonderfully well in abscesses of the breast in women who are long past confinement, I have seen it fail or succeed with difficulty in pregnant women. Noël Fiessinger and Paul Brodin, in experiments with tuberculin, have demonstrated the anergy of persons suffering from diseases of the liver. The seriousness of operations on patients with hepatic infections is also recognized. As Bordet states: "Vaccinotherapy by stimulating the patient to develop the reaction, which the disease is itself exciting, may contribute to the cure, but in such a case it is merely reinforcing salutary processes already at work."

In other words the normal effort of the organism can be sustained and re-enforced. It cannot be created.

b. *Others depending on the nature of the germ.* We repeat, according to the definition which we gave: "The goal of vaccination is to put the organism in the condition in which it would be if it had contracted and recovered from a spontaneous attack of the disease under consideration"; therefore, the resistance conferred by the vaccine will be in direct proportion to that produced by the cure of the natural infection. Now none of the infections to which we apply surgical vaccinotherapy gives definite immunity.

c. *Still others depending on the choice of the vaccine and method of using it.* There can be no chance of setting up immunizing reactions unless the specific vaccine is used. Many failures are due to the non-observance of this fundamental principle. It was the need of assurance that one was making a specific attack on the causal germ in undetermined affections that led to the creation of polyvalent vaccines.

This is not all, since in surgical infections vaccination directed against germs which have had their abode in the organism for a certain length of time, it comes about that by a phenomenon of particular adaptation they take on special characteristics, which results in a new type of organism, and it is no longer enough that a vaccine be prepared from microbes of the same species—microbes of the same cultural characteristics must be used. It is this that makes *autovaccine* successful where stock vaccine has failed.

But there is still more. In a vaccinated patient who seemed to be making a definite recovery, I have sometimes seen a fresh local symptom start and develop as stubbornly as in a non-vaccinated patient. Since I believe that one cannot attach too much importance to the adaptation of the microbes which succeed in protecting themselves against the defenses of the organism while the latter is becoming immunized against them, I asked myself whether my autovaccine failed to act because a new type of organism of microbes had been formed. I prepared a fresh autovaccine and was, in fact, able to arrest again the development of the symptoms. From this I infer that although stock vaccines render valuable service because of the convenience they offer, cases will be found where strictly specific autovaccine becomes necessary, and where this will have to be adapted frequently, so that it may correspond to the adaptation of the germ combated.

It is certain that a vaccine may be more or less efficacious according to the manner in which it is prepared. The choice of culture medium and the process of attenuation of the germs are of undoubted importance. But this is the business of the bacteriologist rather than the surgeon. The ideal before us should evidently be to make the *living virus* of practical utility, as in veterinary medicine.

I have stated that unhappily empiricism hovers over the use of vaccines. It is only by tentative methods, by studying each particular case, that it can be decided what dosage should be employed and at what intervals the injections should be repeated. To be fruitful the practice of vaccination demands an untiring spirit of observation.

BY WHAT ROUTE SHOULD THE VACCINE BE ADMINISTERED?

Generally speaking, the subcutaneous route is adequate. It is the easiest and least troublesome, but it has the drawback that a great part of the vaccine is absorbed locally, creating a local immunity and thus lessening the general immunity which is sought. To insure obtaining the maximum effect the vaccine must be introduced directly into the circulation. The intravenous route permits the use of very much smaller doses. The technique is certainly more delicate.

Besredka urges that the result of the introduction of the vaccine should be the most perfect reproduction possible of the disease against which the vaccination is made. Thus the vaccine must take the same course through the organism and effect the same organ or group of organs as the virus itself. This is the price that must be paid if the syndrome created by the vaccine is to be a faithful tracing of the disease itself and the vaccine is to develop its maximum efficacy.

In the application of these principles Besredka recommends *buccal vaccination* in all infections of intestinal origin. I have tried to carry out the same idea in urinary infections by colon bacilli and usually treat these infections not alone by subcutaneous injections of vaccine but also by causing the patient to ingest a specially prepared vaccine. It has seemed to me that by such procedure I have obtained more satisfactory results.

On the other hand, I believe that the buccal route is insufficient to assure vaccination against those diseases that do not originate in the intestines. By virtue of the principle of local immunity, the vaccine introduced into the digestive tract uses up most of its power in the intestines. Numerous experiences have shown that, at least in certain diseases, the general protection given by the buccal vaccine was insufficient. I need not enumerate all the germs used in France for the preparation of vaccines, Delbet's, Le Moignic and Sézary's lipo-vaccines, Mauté's soda vaccines, etc.

It may be that new horizons are being revealed to us by the discovery of the phenomenon of d'Hérelle. Already Bordet and his assistants, Gratia and Jaumain, have made most interesting therapeutic attempts with the staphylococcus. But the staphylococcus frequently succumbs very easily. Bordet on one hand and Courcoux, Philibert, and Cordey on the other have taken up in the same way the treatment of urinary infections on the anti-colibacillary lytic principle.

These researches deserve to be followed with the most scrupulous attention, as they allow us to form some idea of what may be the future of vaccination.

PARTIAL FAILURES

Failure of the vaccination may be only partial. "It is important to take into account the fact that certain microbes, even if assisted by antibodies, do not allow themselves to become engulfed before they have submitted to the influence of the alterative principles of the leucocytes; the cure of the infection for which they are responsible, therefore, demands the previous formation of an exudate very rich in phagocytes, that is to say, the setting up of a very strong local immunity. In such a case, resistance requires a very definite inflammatory reaction. Hence one cannot speak of an absolute immunity. In other words, when confronted with such microbes (staphylococci, streptococci, etc.), general immunity is by itself not enough to assure *ipso facto* local immunity: an afflux of leucocytes, large enough to cause symptoms, may be accompanied by the appearance of a new lesion identical with the first." (Bordet.)

The results of vaccination cannot be properly appreciated without an understanding of these facts.

MIXED IMMUNIZATION—SERO-VACCINATION

If one tries to establish a parallel between the action of serums and that of vaccines, used specifically, one arrives at the following conclusions, briefly stated:

Serums bring to the organism antibodies ready for immediate use. Unfortunately, the foreign albumin of which they are composed is rapidly eliminated by the organism and the antibodies, which it serves to support, go with it. Thus the immunity conferred is but transitory.

Vaccines have for their object the production of an immunity which is more durable but which requires a certain length of time before its appearance, during which the organism may find itself temporarily in a state of lessened resistance (Wright's negative phase). Now, the subjects of surgical vaccination are already suffering from infection, and injection of microbic cultures, even attenuated, may prove no trivial matter to them.

Would it not, therefore, be advantageous to combine the good points of the two methods, eliminating their inconvenient features? This is the aim of the mixed immunization, active and passive together, of sero-vaccination.

Leclainche, a long time ago, first thought of employing a mixture of serum and vaccine in the treatment of animals; in this case it was used for wheal-worms in pigs, later Calmette and Salimbeni did the same in man for plague. But, unfortunately, this mixed method of sero-vaccination, which has yielded such wonderful results to Leclainche and Vallée in veterinary medicine, when used for certain carefully selected germs, is not applicable in all cases. Too often an excess of serum causes such a saturation of the vaccine that the latter loses its special properties, and the immunity conferred by the mixture of serum and vaccine is not more lasting than that which is given by serotherapy alone. Besredka has demonstrated, however, that it is possible, from cultures of microbes and the corresponding serum, to prepare certain vaccines possessing incontestable, rapid, and durable efficacy. These he calls "*sensitized vaccines*." The principles which underlie their preparation are, according to Besredka, the following:

"The addition of specific serums to the bodies of the microbes having been proved prejudicial to the duration of the immunity, we propose to use only the specific substances in the serums, eliminating the albuminoid and other matter which is abundantly present in the serums. In order to carry out this selection, it was clear that we could not do better than turn to the microbes against which the serums were directed. We know from the work of Ehrlich and Morgenroth that every cell, and particularly every microbe, placed in contact with the corresponding antibody, fixes upon the latter, to the exclusion of every other substance contained in the serum. Having seized the antibody, the microbes do not let go. They may be withdrawn from the serum which bathes them, they may be washed in physiological salt solution, but they will still remain impregnated by the anti-body. It is these microbes which have attracted to themselves the antibody of the serum, which are, so to say, tinged with what is called the amboceptor or specific sensitizer, which constitutes the sensitized vaccines."

This ingenious method of combining serotherapy and vaccination has been used by certain authors in the prophylaxis and treatment of the most diverse infections. I have myself made frequent use of sensitized vaccines in surgery with most encouraging results. Together with my friend Cuvillier, I have demonstrated the valuable aid to be received from Besredka's vaccine preparations, which may be expected from the polyvalent serums of Leclainche and Vallée, which permit the sensitization of all the most frequent pyogenic germs with which the surgeon has to contend.

I desired to describe Besredka's method in this report, because of its importance and practical convenience. If one uses a mixture of serum and virus, one runs the risk, if there is an excess of serum, of conferring on the organism a protection so great that it will not make the effort necessary to the production of active immunity, or, in case the saturation of the virus is insufficient, of favoring the development of symptoms against which one wished to fortify the organism. Sensitized vaccines aim precisely at avoiding this twofold danger.

But this is not their only advantage. In the preparation of the vaccines in general use in human medicine, the microbic cultures are supposed to be treated by physical and chemical agents which dilute them to a greater or less degree. In Besredka's method, on the contrary, the germ is merely passed through the serum, and is inoculated, as one may say, alive. I myself have never yet dared to conform to this practice and have always used sensitized microbes, treated by heat at 56 degrees C. But it is incontestable that a living virus possesses vastly superior antigenic, and consequently vaccinal qualities, and that it should be preferred if its harmlessness can be thoroughly demonstrated. This is a point on which I have already insisted. I have already stated that to bring about the formation of antibodies, the antigen must be absorbed. I have also indicated how the serum, carried to the very seat of infection in local applications, *sensitized* the microbes and made them more susceptible to phagocytosis and to intracellular digestion. From this it will be deduced that sensitized vaccines, microbes charged with certain of their antibodies, will be readily absorbed and will consequently cause the precocious appearance of a great number of antibodies. Thus the characteristic quality of the immunity conferred by sensitized vaccines will be the rapidity with which it is obtained.

It cannot, however, be claimed that Besredka's method represents a sero-vaccination in the exact meaning of the word. By the use of sensitized vaccines, one benefits from a particular method of preparing the vaccines, extremely interesting for the reasons we have mentioned, but one does not obtain the full advantages offered by serotherapy. The microbic bodies absorb only a part of the active principles of the serum, those which facilitate their digestion, which might be compared to the antitoxins in the presence of toxins; but it is far from being proved that they are charged with all of that which, in a serum, goes to re-enforce the organic defense.

On the other hand, there exist the means of effecting a true sero-vaccination, and although up to the present surgeons have not had recourse to these means, I believe it will be well to speak a few words concerning them, for they have rendered such service that others will, perhaps, be glad to know of their existence.

There are three different methods of sero-vaccination—

a. *Mixture method.* This consists, as we have said, of placing the serum in contact with the virus, obtaining thus a neutral product which can be injected. This method presents great difficulties of which we have already spoken.

b. *Simultaneous method.* To obviate the inconvenience of the mixture method, injection of a certain quantity of serum and a certain quantity of virus have sometimes been made at the same sitting *but at different points.* By re-enforcing the organic defense, the injection of serum obviates whatever injurious effect might be caused by the injection of the virus alone.

c. *Dissociated method.* Finally, when immunity cannot be acquired by the mixture of serum and virus, there is still a way in which it may be sought other than by simultaneous injections. The process is carried out in two

sittings. The serum is first injected. This is followed, 5 days later, by inoculation with the virus. This was the procedure that was followed by Leclainche and Vallée when they succeeded in producing sero-vaccination for symptomatic anthrax, and in attacking the problems of the prevention of tetanus, Vallée and I worked with the same principles in mind. As soon as possible after infliction of the wound, we injected the customary dose of antitetanic serum to guard against immediate symptoms. Five days later, under cover of the protection conferred by the serums, we started the active immunization process with iodized tetanus toxin. We observed no untoward incidents in the course of our attempts.

The Respective Indications for Serotherapy and Vaccinotherapy

Surgeons attach great importance to the study of indications for operation, for they know that an operation, excellent in itself, may have deplorable results if it is not dictated by good judgment. The same sensible course must be followed in serotherapy and vaccinotherapy, if we are not to see two promising methods fall into unjust discredit, after having excited a rash enthusiasm. This is why I have been anxious to set forth in its entirety the problem which these questions raise, not concealing its obscurities and difficulties, but endeavoring to abstract some clear idea to guide us in practice.

First of all I wish to repeat, that, until we have more complete information, we must imbue ourselves with this idea, that the rational use of serotherapy or vaccinotherapy is dominated by the fundamental conception of specificity. Neglecting this, one may obtain incontestable therapeutic successes. It is even useful to know that, beside their specific action, serums, like vaccines, have a paraspecific action (colloidaltherapy, peptonic action) which it may sometimes be convenient to utilize, when one is ignorant of the germ of the disease which one is treating, or if there is no specific medicine for the germ.

Except in these cases, one's aim should always be to set up only the specific reactions. By proceeding thus, one will not deprive oneself of the primary paraspecific effects of serotherapy and vaccinotherapy, and will in addition obtain the benefits of their particular specific action.

How is one to chose between serotherapy, the action of which is rapid but transitory, and vaccination, which is slow in taking effect but produces durable results? Here, evidently, one must pass from general to particular grounds and consider cases individually. There are certain points that may be logically deduced from the principle already explained.

The first is that, in general, in the cure of infections, the first place must be given to specific serotherapy. It can have only an advantageous effect to spare the infected organism and immediately re-enforce its defense by the introduction of antibodies ready made. I allow myself to insist upon the importance of the employment of local serotherapy whenever it is possible.

When it concerns prevention of infections, the problem is different. Two cases are here presented which may be seen any day in surgery.

a. The infection feared is one that develops early. It is thus with tetanus and gangrene that may appear in the first few days following infliction of the wound caused by contamination. A quick defense must be made against these infections. There is no time for hesitation. Then rapid action imperially demands serum treatment. But if serum works quickly its duration is short. Now there are cases in which,—

b. on the other hand, the danger is long drawn out. A wound may be very long in healing. For some reason it may retain foreign bodies that carry germs. Cases of tetanus were seen during the war that developed several months after the injury. In these cases, should one continue indefinitely the injections of serum that become less and less efficacious as they are repeated? Assuredly, no. Serum is a medicine of quick but brief action. If duration of effect is desired, recourse must then be had to vaccine, and it is in obedience to these principles that M. Vallée and I produced the tetanus vaccination.

The fact that serums like all foreign albumins are less and less well received by the organism, as I have taken pains to make clear,

shows that they should not be employed except in those cases in which they are absolutely indicated, that is to say, in urgent cases, and I would repeat the statement that serum is the heroic treatment for serious cases. and it is reasonable not to impair the succor it is capable of affording by employing it when other therapeutic means could advantageously be substituted. It is for this reason that one cannot approve the abuse that is made of serums termed hæmopoietic, antihæmorrhagic, etc., used to combat surgical hæmorrhages, operative and otherwise. If such a practice is legitimate in the presence of characteristic hæmophilia, it is no longer so when applied to hæmorrhages of a non-menacing character, or due to an operation. The duty of the surgeon in all cases is to endeavor to assure a perfect hæmostasis and not to have recourse to lesser means, which, without producing decisive effects on the hæmorrhage, alter and vex, as I have stated, the humoral equilibrium of patients to whom they are applied.

Except in critical cases, one is not pressed for time and if the quality of the germs are adaptable, vaccination is better. The theoretical reasons for substituting vaccinotherapy for serotherapy whenever it is practicable are the following: The passive immunity conferred by the serum demands no effort on the part of the organism. This is at once its strength and its weakness. On the other hand, to acquire active immunity the organism is obliged to throw itself into a struggle which is expressed not only in humoral modifications, but also by a complete cellular education. In fact, as pointed out by Bordet: "In the vaccinated animals all the humors are active, while the fresh animal on which the passive immunity is to be conferred is hardly able to take one dose of relatively weak serum." One may also remark that the aptitude to produce antibodies usually persists a long time in vaccinated subjects so effectively that the organic defense remains good a long time after the humoral immunity has become considerably lowered. It seems, therefore, that one might validly place serotherapy, the action of which grows ever less as the injections are repeated, against vaccinotherapy, the effect of which is, on the contrary, re-enforced by each new series of vaccinations. I have already shown the practical conclusions which can be drawn from these theoretical ideas.

The Place Which Serotherapy and Vaccinotherapy Should Hold in Surgery

In spite of all the imperfections which they still present, it is impossible to deny the immense services which serotherapy and vaccinotherapy have already rendered to surgeons. They deserve henceforth to occupy a place in surgical treatment, and it is desirable that all surgeons should become more and more familiar with them and that they should know how to get the best out of them, as they endeavor to do with all the resources which operative technique places at their disposal.

While I am firmly persuaded that the latter will find in serums and vaccines more and more useful and necessary adjuvants that will augment its coefficient of safety, I believe, nevertheless, that the introduction of serotherapy and vaccinotherapy should not be allowed to obscure the great fundamental principles upon which the rational practice of surgery is based.

The war brought forcibly home to us one of these essential ideas, that the organism must be rid as quickly as possible of all mortified tissues, whether occasioned by trauma or by infection. There must be a clean field to obtain a prompt and satisfactory cure. One would be greatly deceived if one thought that the use of serums and vaccines could alter that primary truth. During the war I frequently heard it denied that anti-gangrenous serums possessed any prophylactic value, on the ground that the tissues of a wound, not surgically treated, presented areas of gangrenous appearance in spite of the previous injections of serum. But I replied, without always being believed, that the serum had, nevertheless, acted beneficially in neutralizing the toxins secreted by the germs, and permitting the gangrene to remain a local, and therefore curable, condition, instead of becoming a general toxæmia, almost certain to prove fatal. The logical treatment of wounds should therefore be twofold; surgical, to cut away all the tissues mortified by the traumatism, which have no longer a right of domicile in the body;

serum treatment, to protect the patient against all general complications, septic and toxic, that may arise in the region of the wound.

The impotence of serums and vaccines when face to face with tissue necrosis helps us to understand the difficulties met with in using them in certain chronic diseases, especially tuberculosis. All who have undertaken the cure of that formidable disease have made the same observations. Regarding the results of his experience with tuberculosis vaccine therapy, M. Jousset writes me: "You know as well as I that there is nothing to do in tuberculosis of the bone unless surgery participates in the treatment by removing sequestra, fungosities and necrotic parts. On the other hand, tuberculosis attacking the soft tissues where spontaneous elimination is easy, is *a priori* in the province of vaccinotherapy."

What M. Jousset has stated regarding tuberculosis, which agrees with what I have myself seen, my personal experience allows me to say regarding serotherapy and vaccinotherapy in all surgical infections, and this leads us to ask: Since serotherapy and vaccinotherapy must be considered only as auxilliary to surgery, in what measure and how can they serve as adjuvants to operation?

Employed judiciously in suitable doses the serums and vaccines may sometimes save, and very often limit, the surgical intervention. Reporting in May, 1921, to the Society of Surgery the results obtained by the use of the microbic extracts with which I had at that time been experimenting for more than 3 years and the action of which might perhaps be compared, in certain respects, with that of vaccines, I showed that where they were applied at the commencement of an infection, when only the purely congestive inflammatory symptoms were present, the infection was seen to turn abruptly and the tissues reassumed their normal suppleness and relaxation. When, on the contrary, there was the least tendency to suppuration, this immediately appeared. But instead of being diffuse it gathered to a point, so that it could be evacuated by an operation which caused but slight mutilation, a puncture with bistoury or needle and filiform drainage. Many surgeons have made the same observation. Some have even counted upon the focal reactions provoked by serums or vaccines to procure a spontaneous elimination of sequestra and foreign bodies. Others have not only seen the pus become sterile but even be absorbed. These are eventualities upon which it is better not to depend. No form of elimination is better or more regular than that which is carried out, according to plan, by the surgeon, and I think the serums and vaccines will play a sufficiently useful rôle if they reduce the size of the field of operation, guard against the extension of the infection, and allow a quicker and easier cure.

But it is not here that the chief importance of serums and vaccines lies. I believe that their study must tend to make the results of surgical operations more constant. A great advance was brought about by antisepsis, and, later, by asepsis, which abolished contamination of the patient by the surgeon or his instruments. But if the operator is no longer the origin of infection, in the greater part of his operations he finds it already installed. Infection is still his most formidable enemy. Too much importance can never be attached to the study of what has been termed latent microbism. When one speaks of immunity, one always thinks of the immunity of the organism against its aggressor, the microbe. But the microbe is also a living being and, on its side, the seat of reactions of defense against the organism that harbors it. Which of these two has the better succeeded in protecting itself against the other? That is the enigma which we face each time we operate upon a "*germ carrier*," for we must not conceal from ourselves the fact that our intervention unchains the elements of a conflict of which we can foresee neither the incidents nor the end, since we do not know the respective forces of the two combatants. Here again serums and vaccines give us valuable assistance by allowing us to establish a pre-operative immunization.

The large number of cases of tetanus observed after repeated operations on war injuries led many surgeons to recommend the injection of antitetanic serum before each new operation. It appeared to me, as to my preceptor Quénu, that this indispensable precaution might well be supplemented by the addition of anti-gangrenous serum and on March

21, 1917, I dedicated to the Society of Surgery a communication on the use of Leclainche's and Vallée's serum in the prevention of post-operative infections. At that time, impressed by the flare-ups of infection, sometimes fulminating, that follow operations, I operated no more on war injuries except under the protection of serotherapy or vaccination.

The theories and results derived from war surgery can be transferred to surgery as practiced in time of peace.

In the case of an open infection for which surgical intervention will some day be necessary, there is every advantage in preparing the patient by a pre-operative autovaccination. Convalescence will be greatly facilitated. After having employed this method for many years, on June 26, 1922, I presented before the Académie des Sciences the results that my father and I had obtained, notably in urinary surgery. But the infection requiring operation is not always open. In that event it is not possible to isolate the germ or germs responsible for it, to make use of them in the preparation of an autovaccine. It is still possible, however, to produce a pre-operative immunization, although with less certainty. In such a case one should do as I did at the commencement of my researches in 1916, i.e., use a very polyvalent stock vaccine containing those germs which numerous examinations have shown to be the most frequent in the infection under consideration. But in the course of my work of immunization, particularly in appendicitis, I have observed that the injection of vaccine, especially when given intradermally (intradermo-reaction), provoked in certain patients an extremely acute local reaction analogous to that provoked by tuberculin in the tuberculous. It has seemed to me that this should be interpreted, like the latter, as a peculiar sensitiveness on the part of the patient to the germ under consideration, in this case the colon bacillus. I have used this intradermo-reaction to the colon bacillus before all my operations for chronic appendicitis, and on March 12, 1919, communicated the results of my work to the Surgical Society. I believe that this use of vaccines for prognostic purposes is extremely important. It is, to my mind, of the utmost value to the surgeon to be informed as accurately as possible as to the condition of the terrain on which he is operating. Everyone will have remarked that operations technically simple and satisfactory sometimes end in inexplicable failures, while others that seemed to be performed under less propitious conditions, are followed by uncomplicated healing. This is to be explained on the grounds that, in the first case the operation set free a germ of increased virulence which developed in a terrain of lessened resistance, whereas in the second, the organic resistance was acting normally. The greater part of the symptoms termed "operative shock" are nothing else than the manifestations of a very acute septicæmia. The object of the pre-operative intradermal reaction which I have recommended is to furnish information as to the strength of the organic defenses and to enable us to discriminate between sensitive subjects, upon whom it is better not to operate until their sensitiveness has been lowered by an appropriate vaccination, and patients with normal reaction on whom immediate operation may legitimately be performed.

Researches made by M. Lambret and communicated by him to the Surgical Society on June 22, 1921, confirm my point of view in all respects. Struck by the frequency of pulmonary complications in patients operated on for lesions of the stomach, and finding that the same germs which he could isolate regularly from the surface of the gastric mucosa during his operations were present at autopsy in the lungs of patients who had died from bronchopneumonia following operations on the stomach and in the sputum of patients with pulmonary reaction, M. Lambret, collaborating with Mm. Breton and Grysez of the Pasteur Institute of Lille, had the idea of immunizing patients before operation by vaccinating them for the germs most often met with (bacillus pylori and enterococcus). But in order to vaccinate only those who were "germ carriers" Mm. Lambret, Breton, and Grysez had recourse, as have I myself in other abdominal infections, to the intradermal reaction, operating immediately where the reaction was negative, vaccinating previously in cases where it was positive. The value of this pro-

ceeding may be appreciated when I state that M. Lambret, whom I recently met, told me that with previous vaccination he had been able to perform a series of 50 consecutive operations on the stomach without a single complication, and that when, as a means of control, he had suspended the practice of preoperative vaccination, he had one death in the four cases that followed, which made him more than ever determined not to forego so valuable an adjuvant. I was pleased to find in the researches of M. Lambret a confirmation of what I had presented to the Surgical Society more than 2 years before.

A splendid field is here open to investigators: the study of the terrain in surgery, which includes investigation of the organic defenses and of all forms of microbic adaptation.

In speaking of serotherapy and vaccinotherapy there is a tendency to see nothing in the serums and vaccines but therapeutic means. In closing, I wish to show that they hold out other hopes. In presenting this work I have not tried to conceal the failures of vaccinotherapy and serotherapy nor the obscurity that still surrounds their action. It may even be asked whether the serums and vaccines are not at present in a transitory stage, destined sooner or later to modification. It is for this reason that I have restricted myself voluntarily to general ideas and have not attempted to present results. Wonderful as these last have been, I do not think they have formed my chief interest in the study of serums and vaccines. If serotherapy and vaccinotherapy have enabled me to render valuable services and to assure recovery to many of my patients, they have above all else obliged me, in my desire to employ them rationally, to observe their effects in the hospital and to compare them with the information furnished by laboratory experiments. A new direction has been given to my mind, and I appreciate more fully the necessity that is being more and more imposed upon the surgeon of our day, to think not only as anatomist, but also as biologist.

AN ELECTRO-CHEMICAL INTERPRETATION OF SHOCK AND EXHAUSTION[1]

By GEORGE W. CRILE, M.D., F.A.C.S., Cleveland, Ohio
Professor of Surgery, Western Reserve University

In former publications[1] were given summaries of the various theories regarding the mechanism of shock and exhaustion and conclusions from the researches of my collaborators and myself up to the time of preparation of those manuscripts. In this present report it is my purpose to summarize the reports of various investigations regarding the nature of shock which have appeared in the more recent literature; to describe in some detail the later researches in my own laboratories; to add certain modifications to the theory of the operation of the animal mechanism (based on these laboratory findings) which I have previously proposed; and to describe the practical application of this present conception in the clinic, especially in the management of "bad-risk" patients; i.e., of patients in whom the processes of shock and exhaustion are already initiated.

While the published bibliographical lists are fairly rich in titles bearing upon some phase of "shock," but little work along new lines has been reported. Laboratory studies appear to have been devoted principally to further investigations of the theory that traumatic shock is due to the absorption of tissue poisons[2] and to the study of the distribution of the blood in shock.[3]

Henderson, in collaboration with Haggard and Coburn, has written further in support of his acapnia theory.[4]

From his studies of the alkali reserve of the blood plasma, Raymond[5] has concluded that there is no relation between the relative severity of shock and the degree of depletion of the alkali reserve. Contrary to our own findings he reports that the intravenous injection of acids failed to produce either shock or any allied condition, a finding reported also by Cannon and Cattell.[6] The latter authors note the conserving influence of morphine on the alkali reserve, probably as the result of reduced cellular activity.

Rapport[7] reports a research undertaken for the purpose of determining the possible relation to the production of shock of an over- or under-production of epinephrin. In six out of nine cases he found evidence of hyperactivity of the adrenal glands during the development of traumatic shock, but thinks it probable that this hyperactivity acts as a conserving agent rather than to promote the production of shock.

Of particular interest from the point of view of our own studies are certain of the conclusions of Whipple, Smith and Belt[8] from their studies of the relation of blood proteins to shock.

> The *essential injury* in these experiments is *cell protoplasm injury* induced by a sudden change in the colloidal solution which forms the normal environment of these cells. This may be a new type of cell injury, but it may help us to understand the more complex cell injury which is probably responsible for "surgical shock."

These investigators found that while the presence of injured cells of the kidney, pancreas, or intestine did not seriously modify the reaction which followed a uniform "plasmapharesis",

> . . . . the presence of *injured liver cells does profoundly modify the expected reaction* following a unit plasmapharesis. A fatal shock reaction is almost constant following even a moderate plasma depletion preceded by liver injury.

[1] Crile, G. W. The mechanism of shock and exhaustion. J. Am. M. Ass., 1921, lxxvii, 149-155. A Physical Interpretation of Shock, Exhaustion and Restoration, London, 1921.

[2] Bayliss, W. M. Action of gum acacia on the circulation. J. Pharmacol. and Exp. Therap., 1920, xv, 29-74.
Dale, H. H. Conditions which are conducive to the production of shock by histamin. Brit. J. Exper. Path., 1920, i, 103-114.

[3] Mann, F. C. Experimental surgical shock. Am. J. Surg. (Anesthesia Supp.), 1920, xxxiv, 11-14.

[4] Henderson, Y., Haggard, H. W., and Coburn, R. C. The acapnia theory, now. J. Am. M. Ass., 1921, lxxvii, 424-427.

[5] Raymond, B. Alkali reserve in experimental surgical shock. Am. J. Physiol. 1920, liii, 109-136.

[6] Cannon, W. B., and Cattell, McK. Experimental traumatic shock. Arch. Surg., 1922, iv, 300-323.

[7] Rapport, D. Studies in experimental traumatic shock. Am. J. Physiol., 1922, lx, 461-475.

[8] Whipple, G. H., Smith, H. P., and Belt, A. E. Shock as a manifestation of tissue injury following rapid plasma protein depletion. Am. J. Physiol., 1920, lii, 72-100.

[1] Presented before the International Congress of Surgery, London, England, July 17-20, 1923.

This would indicate that the liver cells are particularly concerned in the peculiar shock reaction which may follow plasmapharesis and lowering of the blood plasma protein values. It may be that this type of shock is not unlike the common "surgical shock."

The evidence in our experiments gives strong support to the theory that in "shock" there is a *primary cell injury* which *precedes* the familiar *clinical reaction.*

The continued studies of Cannon,[9] Stewart and Rogoff,[10] Marine[11] and others on the function of the adrenals and other glands with internal secretion should be included also, as of constant value in the interpretation of the syndrome of shock and exhaustion.

Throughout our own investigations the work of the many investigators in this field has constantly suggested, aided, and checked our studies.

As has been stated in previous publications, our researches which were initiated to investigate the cause of exhaustion due to physical trauma—surgical shock—have been extended to include all the known causes of exhaustion. These investigations have served, first, to identify the organs and tissues which are affected by the various causes of exhaustion; and, second, to ascertain whether or not identical end-effects are produced in these organs by all the causes of exhaustion. That is, they have shown that infection, exertion, emotion, asphyxia, the excision of organs, etc., cause phenomena which are identical with those produced by the commonly accepted causes of shock—physical trauma and hæmorrhage, that identical organs are affected by each of the causes of exhaustion, and that the change in each is the same whatever the cause of the exhaustion.

In each instance, however, the histological picture, the physiological phenomena—alteration in blood pressure, diminution in the alkali reserve, changes in the H-ion concentration of the blood—were end-results. In no instance did our own studies or those of any of the many other investigators in this field indicate the *cause* of shock or exhaustion.

Since every method of physiological investigation had been tried by ourselves or others without avail, we turned our attention to the possibility of applying other methods of investigation.

The uniform finding in our histological researches that progressive changes in the cells of the central nervous system, the liver and the adrenal glands, paralleled the clinical phenomena of stimulation and exhaustion, led us to turn our attention to a study of the ultimate component units of the organism—the cells.

FUNDAMENTAL STRUCTURE AND FUNCTION OF THE CELLS

Every living cell consists of two parts, the nucleus and the cell body, separated from each other by a selective semi-permeable membrane. The cell itself also is separated from neighboring cells or from the medium in which it is immersed by a semi-permeable membrane. The nucleus and the body of the cell cannot be best stained by the same medium, that is, the nucleus takes best an acid stain, the remainder of the cell takes best a basic or alkaline stain.

The content of the cell body and of the nucleus consists in the main of colloidal solutions. Two colloids of different reactions separated from each other by a semi-permeable membrane constitute an electric cell. Each cell of the organism therefore is a true electro-chemical unit—an electric cell.

Since all the organs and tissues of the body are multiples of these ultimate electro-chemical units, then each organ and tissue must be an electro-chemical mechanism, as must the organism as a whole. If the organism is made up of electro-chemical units, then its func-

[9] Cannon, W. B. Some conditions controlling internal secretions. J. Am. M. Ass., 1922, lxxix, 92–95.
Studies on conditions of activity of the endocrine glands, with Griffith, F. R., Am. J. Physiol. 1922, lx, 544–559; with Smith, P. E., Am. J. Physiol., 1922, lx, 476–495; with Rapport, D., Am. J. Physiol., 1921, lviii, 308–337; 338–352; with Uridil, J. E., Am. J. Physiol., 1921, lviii, 353–354; with Uridil, J. E., and Griffith, E. R., Endocrinology, 1921, v, 729–730.

[10] Stewart, G. N., and Rogoff, J. M. Postoperative depletion of epinephrin store of adrenals, Am. J. Physiol., 1921, lvi, 220–230. Action of drugs on output of epinephrin from adrenals, J. Pharmacol. and Exper. Therap., 1922, xix, 59–85. Influence of muscular exercise on normal cats compared with cats deprived of greater part of adrenals. J. Pharmacol. and Exper. Therap., 1922, xix, 87–95. Influence of morphine on normal cats and on cats deprived of greater part of adrenals, J. Pharmacol. and Exper. Therap., 1922, xix, 97–130. Morphine hyperglycæmia and adrenals, Am. J. Physiol., 1922, lxii, 93–112.

[11] Marine, D. Influence of glands with internal secretion on respiratory exchange; with Lenhart, C. H., Am. J. Physiol., 1920, liv, 248–260; with Bauman, Am. J. Physiol., 1921, lvii, 135–152; ibid., 1922, lix, 353–368.

tions must depend upon the laws of physics, and it should be possible to measure variations in its function by physical methods.

We reasoned that if physical methods of measurement could be applied to the various organs and tissues of the body it would be possible to measure variations in cellular vitality with an accuracy comparable to that of measurements of length or of mass by means of the centimeter and the gram; and by the variations in the cellular activity of the different organs and tissues to gain a new insight into the operation of the animal organism and consequently to determine the fundamental processes concerned in the production of shock and exhaustion.

ELECTRICAL CONDUCTIVITY MEASUREMENTS

The applicability of this physical method of measurement to our problem was suggested by the researches of Osterhout on the electrical conductivity of plants; and those of Loeb, Lillie, and others[1] on the permeability of cells in the process of fertilization. We assumed that variations in the permeability of the living cell to the electrically charged elements—ions—of the fluid which surrounds it must parallel variations in irritability in response to stimulation; and therefore, that factors which diminish, suspend, or abolish irritability must also diminish, suspend, or abolish alterations in permeability.

To this end, therefore, a research was undertaken in which measurements were made of tissues from normal adult and immature rabbits, and from fetuses, and from rabbits subjected to various types of exhaustion—insomnia, exertion, fright, infection, surgical shock; to the action of various drugs—stimulant and depressive; to short and prolonged anæsthesia by ether and by nitrous oxide; to the action of adrenalin in single and in repeated doses; to thyroid feeding and to acute iodism induced by the injection of iodoform; to the injection of acids and of alkalies; to the excision of organs—the thyroid, the liver, the adrenals.

The tissues and fluids measured included the cerebrum, the cerebellum, the spinal cord, the liver, the thyroid, voluntary muscle, the heart, the kidneys, the spleen, the lung, the spinal fluid, the blood, the bile.

A complete report of the methods employed in this research with the actual measurements has appeared elsewhere. We[2] shall include here only the general conclusions from our findings.

1. Influences which affect the general physical condition of the organism produce changes in electric conductivity in the dominating reactive tissues, these changes being uniformly and measurably manifested in the brain and the liver. Apparently these changes in conductivity appear more promptly than any gross clinical alteration.

2. Apparently the liver is more promptly and more markedly affected than any other tissue, as animals showing either no or very slight changes in the conductivity of the cerebrum and of the cerebellum will often show a marked alteration in the conductivity of the liver. On account of the wide variation in liver measurements and the apparent susceptibility of this organ to seasonal and environmental changes, the effects of applied agents are best determined by measurements of the cerebrum and cerebellum.

3. A study of the individual measurements from which the averages have been computed seems to indicate that the variations represent slightly different stages in a process that varies in rate in different animals and in the different organs of the same animal.

4. In view of the above indication and the direct evidence of the measurements, we feel justified in the assumption that the first effect of stimulation within the organism is a slight decrease of the conductivity of the liver followed by a rapid continuous rise to above the normal as the state of exhaustion approaches; a slight and prompt increase in the conductivity of the cerebellum followed by a gradual continuous fall; a relatively slower increase in the conductivity of the cerebrum followed by a gradual continuous decrease.

5. These studies indicate that electric conductivity measurements provide a means by

[1] See bibliographical list in article cited below.

[2] Crile, G. W., Hosmer, H. R., and Rowland, A. F. The electrical conductivity of animal tissues under normal and pathological conditions. Am. J. Physiol., 1922, lx, 59–106.

which the interpretation of the normal operation of the organism may be furthered and the progress of pathological processes within the various organs and tissues may be measured.

6. From our findings it would appear that the *intracellular* changes in excitation and exhaustion which are revealed by the microscope are paralleled by alterations in electrical conductivity, and that both the histological and electrical changes bear a direct relation to the vitality of the organ.

MEASUREMENT OF TEMPERATURE CHANGES BY MEANS OF THERMOCOUPLES

The studies thus far summarized appeared to demonstrate a definite relationship between histological changes and electrical conductivity, this relationship constituting strong evidence in support of the electro-chemical theory. Nevertheless, it was necessary to demonstrate that these apparently related findings are not merely coincident conditions but that actual changes in *function* correspond to the observed changes in electric conductivity and in microscopical appearance. Moreover, both histological studies and measurements of electrical conductivity must be prosecuted after the death of the animal, although with proper precautions it is reasonable to believe that the changes noted at least parallel the progress of processes in the living animal. However, to determine finally whether or not the variations in the histological picture and in the electrical conductivity are parts of one and the same process as that manifested by changes in functional activity, it was necessary to devise some method by which the functional changes in the cells might be measured in the living animal. Only by such a measure could it be ascertained whether or not changes in electrical conductivity indicate changes in functional activity. Clinical evidence would appear to demonstrate that this is the case, but clinical evidence cannot be accurately measured, nor does it identify without question the organs which are principally concerned. Some accurate index that could be applied to the organ itself in the living animal was essential.

In an electro-chemical mechanism, variations in functional activity indicate variations in oxidation; variations in oxidation are manifested by variations in heat production. If heat is a constant product of functional activity, then, if we could measure the progressive changes in the temperature of the various tissues and organs during the various phases of excitation and exhaustion under conditions identical with those formerly studied, we not only should be able to check our findings in the previous researches but should be able finally to link those findings with the clinical evidence.

As the first means to this end we decided to use the method of measurement employed by physicists for the measurement of minute temperature variations, that is, to employ thermocouples so constructed that they could be applied to the brain, liver, muscle or other tissue of the living animal.

Reports of this research have been published[1] and as in the case of our electric conductivity measurements, only a brief summary of our findings will be included here.

1. From the very beginning it was evident that variations in the temperature of the brain under varying conditions parallel variations in the histological picture and in the electrical conductivity of the brain under the same conditions. Thus, the progress of exhaustion from any cause was marked by a progressive decrease in the temperature of the brain and the liver, the rapidity of which was in direct relation to the rate at which the degree of exhaustion advanced.

2. The stage of excitement of ether anæsthesia was marked by an increase in the temperature of the brain; but during surgical anæsthesia the temperature fell continuously until death.

3. After hepatectomy the temperature of the brain declined progressively until death, the resultant curve corresponding closely to that produced by continuous ether anæsthesia.

4. Muscular activity, either voluntary or induced by direct electrical stimulation of a nerve, was accompanied by rapid alterations

[1] Crile, G. W., Hosmer, H. R., and Rowland, A. F. Thermo-electric studies of temperature variations in animal tissues. Am. J. Physiol., 1922, lxii, 341-382.
Crile, G. W., and Fricke, Hugo. Application of biological research to medical problems. Tr. Am. Philosophical Soc., 1922, lvi, 237-245.

in the temperature of the brain and the liver corresponding to the phases of the muscular activity—these alterations, however, *being in opposite directions.*

5. *No significant alteration in the temperature of the liver* was produced by the injection of strychnine, of an acid or of an alkali, *although marked and characteristic changes,* corresponding in each case to the clinical phenomena, were produced by each in the temperature of the brain.

6. Exposure of the viscera and abdominal trauma alike produced a rapid fall in the temperature of the brain and the liver, the change in the latter being in part but not entirely accounted for by the direct chilling of the liver substance.

7. The restorative effect of the introduction of hot water into the stomach was marked by an immediate elevation of the temperature of the brain *which measurably preceded—in some instances by a minute or more—the resultant elevation in the temperature of the liver.*

8. Of especial significance were the temperature changes which followed the injection of adrenalin under varying conditions.

a. In normal animals the temperature of the brain was increased by adrenalin, but returned immediately to or below the preceding level;

b. *In normal animals the temperature of the liver was not significantly affected by the injection of adrenalin;*

c. A limited number of observations indicated that the temperature of the spleen, the kidneys, voluntary muscles and intestinal walls was *decreased* by the injection of adrenalin;

d. *In the absence of the liver the injection of adrenalin produced a diminished or no change in the temperature of the brain;*

e. In the absence of the thyroid the reaction of the brain to adrenalin was less than in normal animals;

f. In iodized animals the reaction to adrenalin appeared more promptly and was greater than in normal animals;

g. After adrenalectomy the reaction to adrenalin was approximately the same as in normal animals;

h. In morphinized animals adrenalin increased the temperature of the brain, but this increase was less than in normal animals and was maintained for prolonged periods;

i. After the administration of strychnine, adrenalin caused an abrupt rise in the temperature of the brain and an abrupt fall in the temperature of the liver;

j. After hæmorrhage the injection of Bayliss solution diminished the reaction of the brain to adrenalin;

k. The transfusion of blood after hæmorrhage did not affect the normal reaction of the brain to adrenalin.

Of particular significance were the findings, (a) that in voluntary muscular activity and as a result of the direct electrical stimulation of a nerve, the temperature of the brain and of the liver varies in opposite directions; (b) that upon the introduction of hot water into the stomach the reaction of the brain in increased temperature precedes that of the liver; (c) that the temperature of the liver is but little altered or is unchanged by the injection of adrenalin; of strychnine; of an acid; of an alkali.

The findings in these studies which accord with the histological studies and the electrical conductivity measurements support the conclusions: (a) that the brain is the tissue upon which depends the reactions of the organism to stimulation; (b) that the thyroid and the adrenals play essential parts in the production and maintenance of these reactions; (c) that in the performance of its function the brain is indissolubly linked with the liver.

The lack of response of the brain to adrenalin in the absence of the liver together with the opposite reactions of the brain and the liver form vital links in the chain of evidence whereby we may determine the function of each in the electro-chemical operation of the animal mechanism, and indicates for the liver a new rôle of highest importance.

MEASUREMENT OF ELECTRICAL CAPACITY

If our conception that the organism is operated by means of electrical charges produced by oxidation and accumulated in the cells is correct, then measurements of the

capacity of the cells to store electricity would give information of the greatest value. An original method and apparatus for this purpose have been devised in our laboratory by Hugo Fricke, Ph.D., and measurements are being made in collaboration with C. Nusbaum, Ph.D., of the Case School of Applied Science, and others. Dr. Fricke's initial measurements indicate that the cells have a very high capacity for the storage of electricity.

From these measurements it is possible to calculate the thickness of the semi-permeable membrane of the cells which are of the order of 1/10,000,000 of a centimeter in thickness. It would appear that this membrane is an oil film of one layer of oil molecules in thickness. Such a membrane in itself is an ideal means for the storage of high electrical charges.

These biophysical studies offer strong evidence in support of our fundamental premise that the cells of the organism are electro-chemical units. The efficiency of an electric battery depends upon the maintenance within it of a difference in potential. The maintenance of life which we conceive to be dependent upon a difference in potential in the organic battery would demand, among the various other things, a constant supply of oxygen and a constant supply of a solvent and catalyst.

It is of importance, therefore, to consider the essential rôles of water and of oxygen in the cell.

THE ESSENTIAL RÔLES OF WATER AND OF OXYGEN IN THE CELL

Water. The properties of water which make it of essential value in the cells may be briefly summarized as follows: Water is the only medium in which a colloidal system can be established; water has a greater catalytic power than any other substance; water is a chemical activator; water has a greater specific heat than any other substance; pure water is a non-conductor of electricity; "moreover it is only in the presence of water that oxygen has the power of oxidizing rapidly" (Mathews); and therefore before oxygen can become available for use within the cell it must be dissolved in water.

Oxygen. The mechanism within the cell for the utilization of oxygen has been well described by Mott:[1]

> If living cells are examined microscopically with dark-ground illumination, they are seen to be filled with small granules or globules, each of which, after escaping from the cell, remains discrete. They are refractile, and appear white and luminous; this is due to a delicate covering film of a lipoid substance which encloses a colloidal fluid, probably consisting of a solution of salts and cell globulins. When the cell dies this colloidal fluid is coagulated, and the precipitated proteid substance is massed together into little blocks—the Nissl granules; the intervening denser colloidal substance is continuous with the colloidal substance of the axon and dendrons. The film that covers each globule is stainable by vital methylene blue, and a living nerve cell stained by vital blue presents the appearance of an emulsion of minute, faintly blue globules. If the living cell thus stained be kept in an atmosphere of nitrogen in a warm chamber the stored oxygen is used up and a leuco-base is formed, causing the globules to lose their color, and the cells appearing of a greenish tint. On admission of oxygen the living cell again becomes blue. It thus appears possible that these granules represent a large oxygen surface, like spongy platinum, within the cell. When the cells die, the lipoidal film of the globulin-containing fluid is destroyed, coagulation occurs, and the Nissl granules are formed. These facts accord with the knowledge that stimulation of a piece of nerve causes practically no metabolic change or using up of oxygen; therefore the mere conduction of a stimulus along a nerve does not entail loss of neuropotential. The chemical processes incidental to the using up of nervous energy in the neuron take place in the cell itself and at the synapses of the terminal fibrillæ, and for this reason it is that the blood supply of the gray matter is six times that of the white matter. In all active neural processes oxygen is used up and carbonic acid is produced which escapes into the circumambient cerebrospinal fluid. One stimulus differs from another that is discharged into a cell by variation in modes of motion, and it is conceivable that the granules which fill the cell are sensible to the varying modes of motion, and an oft-repeated stimulus suffices by the establishment of a biorhythm in the cell to pass through to the intercalary neuron with little expenditure of neuropotential, whereas a new stimulus which requires a concentration of attention must be either transformed or reinforced before connection of the terminals of Neuron I with Neuron II can take place, and this involves a using up of neuropotential.
>
> It is known that a continuous supply of oxygen is essential for consciousness. The bulk of the cortex is supplied by the internal carotid arteries;

[1] Mott, F. W. War Neurosis and Shell Shock. London: 1919 11–14, 15.

compression of these arteries causes loss of consciousness in about five or six seconds. Histological investigation tends to show that the intercalary neurons have no store of oxygen in their cytoplasm; they depend, therefore, upon a continuous renewal of the oxygen in the circumambient fluid; consequently, as soon as the capillary circulation ceases, they feel the effect of lack of oxygen and cease to function, causing dissociation to occur. It may be hypothecated that a violent emotion such as fright can, by its influence on the vasomotor center and the heart's action, causing a fall in the blood pressure, produce an immediate lowering of oxygen tension in the fluid, and thereby suspension of function of the intercalary neurons of the cortex, followed by dissociation of the cortical perceptors and loss of consciousness.

Oxygen—the "acid-maker"—then is essential to the life of the cell. Oxidation produces acids. These acids produce the essential alterations in the difference of potential between the nucleus and the cell-body and probably between parts within the cytoplasm (Mott) as a result of which accumulations of acid and an adaptive discharge of energy are provided. Water carries the oxygen in solution to the cells; dissolves the acid by-products of oxidation; and bears them away from the cells, thus constantly restoring the acid-alkali balance which is as constantly altered by the acidulating oxidation. In accordance with the electro-chemical conception, therefore, water and oxygen in a vital and inseparable relationship make possible the electrical variations within the cells, the manifestations of which constitute life.

These biophysical studies appear to justify the following conclusions regarding the operation of the cells.

Oxidation takes place only in cells; but cells have the power of oxidation only when there is a difference in potential between the nucleus and the cytoplasm. The difference in potential is maintained by oxidation.

If the electrical charges of the cells are produced by oxidation, then it follows that the part of the cell having the highest rate of oxidation, viz., the nucleus, would be positively charged as compared with that part of the cell which has a lower rate of oxidation, viz., the cytoplasm; and the electrical current would pass from the point of higher potential —the (comparatively) positive nucleus—to the point of lower potential—the (comparatively) negative cytoplasm.

If not only the constituent cells but the organism as a whole operates in accordance with physical laws as an electro-chemical mechanism, it is necessary to identify an organ or tissue of highest potential, and an organ or tissue of lowest potential; and to identify the direction of the electrical currents between them. Our biophysical studies appear to indicate that these two "poles" of the organic mechanism are the brain and the liver. That the cortex of the brain has a higher rate of oxidation than any other organ or tissue is probable, for Alexander and Cserna's figures show a consumption in the brain of 0.360 cubic centimeter of oxygen per gram-minute as compared with 0.004 cubic centimeter in skeletal muscle.

Our temperature measurements of the variations in temperature in stimulation showed a marked increase in the brain as compared with a decreased or unaltered temperature in the liver and other organs and tissues.

The opposite effects of stimulation and of exhaustion on the electric conductivity of the brain and of the liver indicates a specific antithetic electric relationship between them.

Other evidence in favor of this assumption is found in the following facts regarding the interrelationship of the brain, the liver and the adrenal glands.

The liver and the brain and oxygen without the adrenal glands are inert.

The adrenal glands and oxygen and the brain without the liver are inert.

The liver, the adrenal glands and the brain without oxygen are inert.

The liver, the adrenal glands, the brain and oxygen together, are inert when the differential stainability of the nerve cells is lost—that is, when the nerve cells have ceased to be efficient batteries.

Such an interrelationship cannot be demonstrated in regard to any other organs or tissues. The function of the adrenal glands being the control of oxidation, these facts considered in their relation to the experimental findings cited above appear to indicate that the brain represents the positive

pole and the liver the negative pole of the organic electro-chemical mechanism.

In accordance with this conception, since all cells of the body are immersed in fluids which are rich in electrolytes, it would be by means of those fluids and the nerves that the circuit between the point of highest potential—the brain—and that of lowest potential—the liver—would be completed.

When the oxidation in the brain is increased by psychic, traumatic, or chemical excitation, the electricity produced by the increased oxidation would pass from the brain along the nerves to the areas of lower potential in the muscles and glands and finally to the point of lowest potential—the liver, returning to the brain via the electrolytic solutions in which the system is immersed.[1]

DEFINITION OF SHOCK AND EXHAUSTION

The conception that man is an electro-chemical mechanism supplies an interpretation of the principal phenomena of quiescence, stimulation, and exhaustion which constitute normal life; it supplies a new basis for the analysis of pathological phenomena.

In accordance with this conception, exhaustion is the result of a diminution of the difference of potential between the poles of the organism, due to a decrease in the brain, which in turn results from a decreased difference in the potential in its constituent cells. This conception explains the identity of the phenomena of exhaustion and the progressive degrees of exhaustion to "shock." When the difference in potential reaches zero, the organism is dead.

CLINICAL APPLICATION OF THE CONCEPTION THAT MAN IS AN ELECTRO-CHEMICAL MECHANISM

If the conception that man is an electro-chemical mechanism is correct, then it should be possible to apply the laws of physics and chemistry to the interpretation of the action of therapeutic agents and measures. Since the electro-chemical theory identifies the organs, the integrity of which is essential to the efficient operation of the mechanism; it should indicate the means by which the organs may be safeguarded against the processes of disease and injury; it should determine the most efficient means of supplying the essential elements of the cells—water and oxygen; it should emphasize the paramount necessity of rest and sleep; it should indicate the need of aiding failing organs by the administration of their essential products; it should direct the selection and gauge the safe application of anæsthetics; it should determine the selective application of drugs; it should guide the hand of the surgeon; it should lead the clinician to protect his patient against the excessive driving of environmental as well as of internal stimuli.

For the past 2 years the treatment of the patients in our clinic has been based upon the conception that the difference in potential between the nucleus and cytoplasm of the cells as well as between the essential organs of the electro-chemical system must be maintained; and in accordance therewith we have adopted the following main principles as our guide in the protection and restoration of our patients:

1. The organism needs an abundant supply of fresh water.

2. An abundant supply of oxygen must be delivered to the cells.

3. The permeability of the selective semi-permeable membranes must be maintained within a normal range.

4. Both the local and the general temperature of the body must be kept at or near the normal.

5. An abundance of mental and physical rest and an abundance of sleep are essential.

6. The physical structure of the cells must not be impaired by the indirect effects of the trauma of the operation nor by the anæsthetic.

By the practical application of these principles the two essential factors in the maintenance of the integrity of the electro-chemical system are assured, provided recovery is anatomically possible and the disintegration

[1] In connection with these conclusions recent investigations by Cannon and by Renauld-Copart are especially significant.

Cannon, W. B., and Griffith, F. R. Studies in the conditions of activity of the endocrine glands: X. The cardio-accelerator substance produced by hepatic stimulation. Am. J. Physiol., 1922, lx, 544–559.

Renauld-Copart, H. Contribution à l'étude du metabolisme cerébral par la methode des circulations partielles. Arch. internat. de physiol., 1921, xvl, 21, 43.

of the cells has not progressed to the early stages of inevitable dissolution; that is, provided the acid-alkali balance—the difference of potential—within the cells is maintained or restored, and their internal respiration is protected.

Every patient is given the benefit of the application of these principles, modified only by the nature of the disease processes in the individual case.

While the treatment of each patient is individualized, nevertheless, the employment of the protective measures we shall describe has become practically a routine; for in all cases, and pre-eminently in the case of the "bad-risk" patient, the management is based on *possibility* and directed by *probability*, not by the physical state of the individual patient at the moment. This conception is comparable to the principle of preventive medicine; that is, in the case of the "bad-risk" patient we do *in advance* of exhaustion or shock all that we would do should these develop.

The practical application of the principles cited above is achieved by the following measures:

In "bad-risk" cases, nitrous oxide-oxygen *analgesia*—not anæsthesia—with local anæsthesia is employed to avoid further interference with the already impaired internal respiration of the cells. The trauma of the operation is divided. In cases of hyperthyroidism, if the operation produces an exacerbation of the symptoms, the operation is stopped at any point and the wound packed open with flavine or sterile gauze, closure being deferred until it is warranted by the condition of the patient. Water is urged by every route and to ensure the readiest possible hydration of the cells 3,000 cubic centimeters is routinely given daily by hypodermoclysis by Bartlett's method. Oxygenation of the cells is promoted by the transfusion of whole blood before operation, during operation, and after operation, according to the indication. To assure the maintenance of an adequate circulation—which is essential to the supply of water and oxygen to the cells, digitalis is administered routinely in those cases in which the myocardium is impaired, a condition most commonly seen in cases of hyperthyroidism. Rest and sleep are promoted by control of the environment and by narcotics, unless there is present an already depressed liver function, as in jaundice, for the function of both the brain and the liver is depressed by narcotics, especially by morphine. In abdominal cases moist hot packs are applied immediately after operation for the support of the liver cells.

The environment of the patient is controlled from the moment of his entrance to his exit from the hospital.

With the gradual extension of the application of these measures based upon the electro-chemical conception the mortality rate of every type of case has been diminished, and the operability has been extended until now no case is considered inoperable unless the stage of final dissolution is initiated.

The efficiency of any surgical method must depend upon its effects—upon (a) the postoperative mortality; (b) the postoperative morbidity. Testimony regarding the second of these points is primarily subjective and is not amenable to statistical compilations. While figures regarding the postoperative mortality demand analysis as to their relation to the various degrees of exhaustion in each patient, in the mass and over periods of years their indications are of positive value. For that reason there are included here the following mortality statistics of operations performed during the post-war period, since it was the vast experience gained in war service, not only in personal observations of wounded and exhausted soldiers, but also, and of inestimable value, in conferences and interchange of opinions with my colleagues, which has guided the later researches and the formulation of the principles in accordance with which our surgical patients are managed.

During the period from 1919 to the present date (June 21, 1923), the mortality rate of the surgical service at Lakeside Hospital has fallen from 2.4 to 1.3 per cent; the mortality rate of 1,090 thyroidectomies has been 1.8 per cent; of the last 230 of these 0.8 per cent; the mortality rate of the last 1,322 ligations has been 0.6 per cent and a series now in pro-

gress (June 21, 1923) includes 466 consecutive operations for exophthalmic goiter without a death.

SUMMARY

1. There is much evidence in support of the conception that man and animals are electro-chemical mechanisms constructed on the pattern of the constituent cells, each of which in itself is an electro-chemical mechanism.

2. In accordance with this conception—

a. Cells have the power of oxidation only as long as there is a difference in potential between the nucleus and the cytoplasm; a difference in potential is maintained only as long as there is oxidation.

b. The nucleus of the cells as compared with the cytoplasm is positive; the cytoplasm as compared with the nucleus is negative. The brain as compared with the liver is positive; the liver as compared with the brain is negative.

c. Since electricity flows from a higher to a lower potential and since oxidation in the brain is the highest, we may suppose that the oxidation electrical wave would pass down the nerves from the area of higher potential in the brain to the areas of lower potential in the muscles and glands, and since the liver has the lowest rate of oxidation—hence the lowest potential—the current would finally reach that area, whence it would return through the electrolytic system to the brain, thus completing the circuit.

3. The following facts are interpreted by the hypothesis that the body as a whole is an electro-chemical mechanism, the positive pole being the brain, the negative the liver, the connecting wires the nerves, the salts in solution the electrolytic fluid in which the electro-chemical mechanism is immersed.

a. When either pole, i.e., the liver or the brain, is removed or destroyed, the organism perishes.

b. If the difference in potential within the cells, no less than the difference in potential between the poles (the liver and the brain), is dependent on the supply of electricity by oxidation, then it follows that, if the organism is deprived of oxygen, the existing difference in potential within the cells and within the organs is lost and equilibrium, or death, is established.

c. The facts (1) that water is a non-conductor and a solvent whereby the atoms within the colloidal solutions of which the cells are composed are enabled to take on electrical charges or to become ionized; and (2) that ionization is essential for electrical communication, suggest the essential rôle of water in living processes.

d. Since the speed of chemical action and the electrical conductivity are fundamentally controlled by heat and cold, it follows that in an electro-chemical mechanism there must be an optimum temperature as well as a lethal cold and a lethal warm temperature. Abdominal surgery in the colder months in unwarmed front area huts illustrated this point by a forbidding mortality rate.

e. The opposite effects of stimulation and of exhaustion on the temperature and on the electrical conductivity of the brain and of the liver, the muscles and other tissues in the splanchnic area, would be explained by the conception that the driving power depends upon the difference in potential between the brain and the liver, muscles, and other organs. Hence, if a stimulus caused only the potential of the brain to rise and the liver remained unchanged, the difference in potential, hence the driving power, would be correspondingly less.

4. The electro-chemical theory would interpret the specific antithetic action of adrenalin upon the temperature of the brain and of the liver and other organs in the splanchnic area.

5. It would interpret the increase in electrical conductivity of the brain by iodine, iodoform, and thyroid extract (hyperthyroidism); and the decreased conductivity of the brain after thyroidectomy.

6. It would interpret the interference with digestion by the strong emotions, by injury, by pain, by infections, etc., for the splanchnic processes are inhibited while the brain is stimulated. It would interpret the antithetic effects of fear and faith, and the failure of health in man and animals under the stress of chronic fear or anger or other strong emotions.

7. This theory would suggest that the essential function of sleep is to provide a period during which, in the batteries which drive the organism, the difference in potential decreased by the activities of the day, is restored.

8. It would interpret the fact that in surgical operations, if a state of negativity and the internal respiration are maintained, there is no surgical shock.

9. The state of negativity is maintained by:

a. Exclusion of fear by management, by operation in the patient's room, by morphine, by analgesia;

b. Exclusion of traumatic stimuli by local or regional anæsthesia, by gentle handling, by protection of the wounds from the irritation of the air;

c. Exclusion of stimulation by stimulant drugs.

10. The entire process whereby the state of negativity is secured and the internal respiration—difference in potential—of the cells is maintained is included in the combination of methods of pre-operative and post-operative management and of surgical technique which is called anociation. The internal respiration is maintained by fluids, by warmth, by blood transfusion, by rest, by sleep, and by the avoidance of deep inhalation anæsthesia.

11. Finally, and included in the above, the theory that man is an electro-chemical mechanism interprets many of the phenomena of life.

EXPERIMENTS ON THE INFECTIOUS ORIGIN OF THROMBO-ANGIITIS OBLITERANS AND THE ISOLATION OF A SPECIFIC ORGANISM FROM THE BLOOD STREAM

By HAROLD M. RABINOWITZ, M.D., Brooklyn
Associate Surgeon, Beth Moses Hospital

THROMBO-ANGIITIS OBLITERANS has long been known as the "Hebraische Krankheit," as the disease frequently occurs among Jews, as often in young adults as in the aged. Briefly, the patients complain of indefinite pains in the foot, calf of the leg, or in the toes, and rather early in the disease the coldness of the extremity is marked. One of the first symptoms to appear, long before there are any objective disturbances is the shooting, cramp-like pains in the leg, followed by evidences of erythromelalgia of the toes, trophic disturbances, and finally dry gangrene.

The well-known theories of von Winiwarter and von Manteuffel, that the obliteration of the vessel is due primarily, on the one hand, to a proliferation of the intima, and on the other, to a primary arteriosclerosis, has long been religiously adhered to, and dogmatism with its cramping tendencies crept in until Buerger published his brilliant contribution to the pathology of this disease. These findings are summarized as follows:

"Most of the larger arteries and veins of the amputated limbs were found obliterated over a large extent of their course. The obliterative process can be studied at any stage in its development, if enough vessels are examined. All stages in the occlusive change may occur in the various vessels of an extremity, or at times in the same vessel, in different parts of its course. The occlusion of the vessels is affected by red obturating thrombi; these become organized, vascularized, and canalized.

"Certain changes in perivascular tissues, in the adventitia, media, and intima, regularly accompany the occluding process. There is moderate thickening of the intima; this is never sufficient to cause marked narrowing of the lumina of the vessels, and does not seem to play any considerable rôle in the genesis of thrombotic process. The media and adventitia show cellular infiltration and vascularization wherever thrombosis has occurred. The occluding masses frequently terminate abruptly in apparently normal vessels. The changes in the media never extend into the walls of the vacant portions of the vessels; usually they terminate before the end of the obturating tissue or thrombus is reached; indeed, the dependence of the media changes upon the organization of the thrombi can be demonstrated in many places."

By a study of what Moynihan has ventured to call the "pathology of the living, that is, of morbid processes in their course rather than when their race was fully run," a very profound change has crept over our knowledge of thrombo-angiitis obliterans and other diseases of unknown origin. This was followed by another stage, the stage of combined research, in which strict, sober, clinical observation, inductive and deductive processes of reasoning, and experimental inquiry are linked together. The search for an explanation of the clinical phenomena of this disease has prompted the writer to choose the method of combined research.

After carefully observing the clinical manifestations of thrombo-angiitis obliterans, extending over a period of 10 years, the infectious origin of this disease has manifested itself in all phases of study. From May, 1922, to April, 1923, 10 cases of thrombo-angiitis obliterans were under my personal supervision, 5 of which were studied at the Beth Moses Hospital, with most extraordinary care and precision. Considerable interest was aroused as a result of certain observations, which pointed very strongly toward the bacterial origin of this disease.

First, the frequent changes in the color and temperature of the part affected, at times warm and pink, and at other times cold and

cyanotic, could not be accounted for by the occlusion of the dorsalis pedis and popliteal arteries.

Secondly, it was a common occurrence to find these patients sitting along the side of the bed, with the affected extremities hanging down, and wrapped about with various materials. This position was most comfortable for them and they even slept propped up along the side of the bed. To be sure, the circulation in the affected limb, already hampered and checked by thrombotic changes, was not aided by the lowering of the limb.

Thirdly, all 5 cases were transfused from three to four times, beginning with 250 cubic centimeters, and increased up to 500 cubic centimeters. Twenty-four hours after the transfusion, all showed a distinct line of demarcation about the gangrenous lesion, the edges of which oozed bright red blood, and the area immediately surrounding the lesion assumed a healthy pink color. Here again one perceived that the additional donor's blood reached the affected part notwithstanding the obliterated popliteal and dorsalis pedis arteries. Right here it may be well to quote Buerger: "The recent red thrombosis may involve large portions of arteries or veins and is not secondary to the gangrenous process. It occurs even when no gangrene is present." The formation of gangrenous lesions, therefore, seemed to be independent of the extent of thrombosis and occlusion of vessels.

Fourthly, 48 hours after the transfusions, all 5 patients complained bitterly of an increase in the pain and burning of the affected parts, and on close examination gangrene which had been limited to the toes, had spread about 2 inches up the anterior surface of the foot. Since the blood supply to the affected parts was improved immediately after transfusions, the aggravation of symptoms 48 hours after transfusion called for an explanation.

Fifthly, about 5 days after the transfusions, all 5 cases developed a vesicular rash over the anterior and posterior surface of the foot. The majority of these vesicles were pin point in size, though some were slightly larger. On pricking these vesicles, they were found to be devoid of fluid, but, being under tension, probably contained gas. Cultures from these vesicles proved to be sterile. I have since observed these pin-point vesicles in 5 other authentic cases. They are usually found in the apparently unaffected skin adjacent to the lesions, and are quite characteristic in this disease.

The following deductions have been assumed:

1. The gangrenous lesions are not merely the result of mechanical obstruction but are due to some other agent which has a direct action upon the local tissues as well as its blood supply. Buerger states: "The intensity of the cellular and vascular change seems in general to depend upon the activity of the organization of the clot; however, in some cases it seems to be sufficiently marked to make it appear that the same agent which calls forth the coagulation of the blood is also effective in producing the mesarterial lesion."

2. That the pain and burning is not due to thrombosis with its resulting stasis, since they seem to be relieved in the position that helps to produce venous stasis. Another agent seems to be responsible for the aforesaid symptoms.

3. The experimental production of an extension of the local lesion by the addition of fresh donor's blood 48 hours after its injection, seemed to point a suspicious finger at some agent which was activated by fresh blood elements. As to what causes this extensive thrombosis of the veins and arteries, Buerger was inclined to believe that mechanical conditions, such as slowing of the circulation and arteriosclerotic changes, may be factors, but that some *additional agent*, be it tôxic or otherwise, must be at the same time responsible.

4. The appearance of an abundance of gas-filled vesicles 5 days after transfusion seemed to be directly related to the addition of a fresh supply of blood.

Certain organisms have long been known for their special affinity for blood elements and, working along these lines, I have attempted to isolate an organism from the lesion produced in this disease, followed by the usual chain of failures. I have finally decided that it was not due to the absence of a specific organism, but rather that the method of seek-

ing it at its habitat was at fault. The following procedures were therefore carried out in order to prove this contention.

First Stage

On my service at the Beth Moses Hospital, a given case of actually proven thrombo-angiitis obliterans, with a lesion of the great toe and obliterated dorsalis pedis, accompanied by the usual symptoms of pain, burning and objective symptoms of the part affected, was selected. Three leeches were applied to an aseptically prepared ankle of the affected limb. The blood from these leeches was immediately extracted, centrifuged in sterile test tubes, and incubated. The hæmolyzed serum was then removed and about 5 drops injected subcutaneously into an apparently healthy portion of the calf of the affected limb. After 48 hours, the usual signs of inflammation appeared, over a considerable area, surrounding the site of injection. This was followed by a peculiarly purplish hue. One week after the injection, an area of superficial gangrene appeared about 2 inches below the needle puncture. This area of gangrene had a sharp line of demarcation (Fig. 1); the longest diameter being about 2 centimeters in length, longitudinally placed, with a transverse diameter of about 1 centimeter. Two weeks after the first injection, signs of fluctuation above the area of gangrene, were elicited. This area was incised and the sanguineous pus examined bacteriologically, and cultured in the laboratory of the Beth Moses Hospital. Sub-cultures were made, and due to lack of facilities for animal experimentation the work was transferred to my laboratory for further investigation.

Differential Characteristics of the Organism Isolated

This organism is a gram negative, aerobic, facultative, anaerobic, freely motile bacillus, medium sized, rod shaped and beaded, bipolar in appearance, containing metachromatic granules (Fig. 4), measuring about five-tenths of a micron in diameter and from five-tenths to one micron in length. It forms no capsules and produces no spores. Flagellæ have not been demonstrated. They stain readily with

Fig. 1. Gangrenous lesion in calf of leg.

ordinary aniline dyes, though not intensely, and grow on the ordinary media but most luxuriantly on Loeffler's media. The organism ferments glucose, saccharose, and mannitol, producing gas and acid reaction, but does not ferment lactose. The indol reaction on sugar-free broth is negative. On agar, the colonies are scanty, raised, and smooth, rather translucent, colorless, and round, with a sharp border. After 24 hours' incubation at 37° C. the colonies attain a diameter of about one-half millimeter. In broth, there is a uniform clouding, a characteristic cadaveric odor, and a moderate flocculent sediment. In gelatin stab, the growth is filiform along the line of puncture. Liquefaction begins on the sixth day and terminates about the twelfth day. On Loeffler's blood serum the growth is glistening and abundant, and liquefaction begins on the third day. The organism grows best at 37° C., maximum temperature 50° C., minimum at 20° C.

On account of the anticoagulative and hæmolytic tendencies of herudin (the active principle of the heads of leeches) leeches were utilized for further experimentation.

I. Leeches were applied over the ankle of the apparently normal skin of the affected limb, the blood extracted and emptied into a sterile test tube, centrifuged, and incubated. The pink hæmolyzed serum (a few drops) was injected into the inner surface of the right ear of Rabbit 1.

II. Leeches were applied over the vein of the elbow of the same patient and the blood extracted and emptied into a sterile test tube containing 2 per cent citrate solution centrifuged, incubated, and the hæmolyzed serum injected into the inner surface of the right ear of Rabbit 2.

III. Ten cubic centimeters of blood was drawn (per syringe) from the vein of the other elbow and emptied into 2 per cent citrate solution, incubated, and centrifuged. The clear non-hæmolyzed serum was then injected into the left ear of Rabbit 1 as a control. The fields of operation were all prepared under the most rigid asepsis.

Three days later, the vessels of the right ears of Rabbits 1 and 2, injected with hæmolyzed serum (derived from the diseased ankle and the unaffected elbow of the patient), were considerably dilated. One week later the smaller vessels about the site of injection were completely thrombosed, and, at the end of 10 days, a gangrenous area, with its long axis parallel to the length of the main vessel, with a sharp line of demarcation, appeared in the right ears of both Rabbits 1 and 2. A very scanty grayish discharge could be squeezed out from underneath the sharply defined border of these gangrenous lesions. All about these lesions there was an area of purplish discoloration, characteristic of venous thrombosis. Cultures made from these lesions showed a gram negative, freely motile bacillus, with the same cultural characteristics as that of the bacillus isolated from the lesion produced in the calf of the leg of the given patient.

The left ear of Rabbit 1 which was injected with the clear non-hæmolyzed serum, derived from the blood of one of the veins of the elbow as a control, showed no lesion whatsoever, not even engorgement of the vessels.

A bouillon culture of this bacillus derived from the lesion of the rabbit's ear was injected into both ears of Rabbit 3, and 3 days later a terrific engorgement of the vessels of the ears appeared, with considerable thrombosis and purplish discoloration. After 10 days, several areas of ecchymoses appeared, but no gangrenous area resulted.

Several leeches were then applied to the veins of the elbow of a normal human being and the blood extracted, emptied into 2 per cent citrate solution, centrifuged, incubated, and both, the serum and the solid contents of the blood, cultured. These cultures proved to be sterile. The sterile hæmolyzed serum was then injected into both ears of Rabbit 4 and no lesion appeared at the end of 10 days.

A subculture from broth was then transferred to a Loeffler's media to which had been added several loopsful of the sterile solid contents of blood drawn from the vein of the normal human being under the most aseptic precautions. After 24 hours' incubation, a loopful of this culture was immersed in several drops of sterile saline, and the suspension injected into the left ear of Rabbit 4. Several drops of a fresh bouillon culture were injected into the right ear of the same rabbit. After 5 days, considerable engorgement of the vessels of both ears was quite evident, accompanied by a purplish hue and an increase in the temperature of the local part. On the eighth day, the right ear injected with the bouillon culture, showed no additional changes, whereas the left ear injected with a saline dilution of a culture derived from Loeffler's media, to which had been added the solid contents of blood derived from the vein of a normal human being, showed the following: A gangrenous area, about 1 centimeter long and 0.5 centimeter wide, situated at the base of the ear and typical of the lesions produced in the Rabbits 1 and 2.

About 4 weeks after the inoculation of a pure culture of this organism into the ears of Rabbits 1, 2, 3, and 4, gangrenous lesions appeared on the plantar surfaces of the feet of Rabbits 1, 3, and 4, near the heels and at points corresponding to the great toes, analogous to those seen in thrombo-angiitis obliterans. On and about the time of the appearance of the lesions on the feet, Rabbits 1, 2, 3, and 4 fed poorly and were wont to huddle up near the stove, as though they tried to keep warm. They took on a peculiar gait, and moved about on their knees, so as to protect the plantar surface of the feet from pressure. Sections of the lesions and blood supply of the thigh, leg, and feet showed some very interesting findings similar to those found in the vessels of patients suffering from thrombo-angiitis obliterans (Figs. 5, 6, 7, 8, and 9). In Rabbit 3, no lesion appeared in the ear after inoculation, but the typical lesion appeared on the left foot, which phenomenon proved the tissue predilection of this organism. The bacillus was isolated in pure culture from the gangrenous lesions on the plantar surfaces of

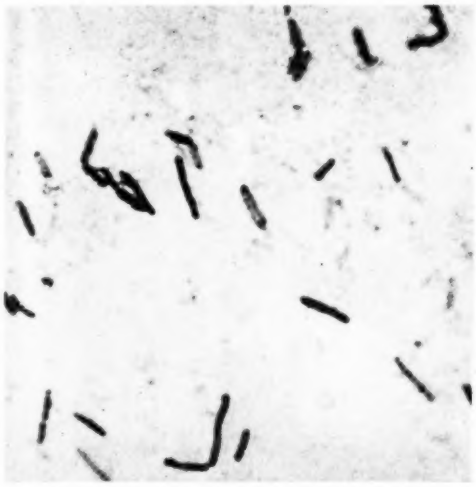


Fig. 2. Organism isolated from the blood stream of thrombo-angiitis Case 3. Note the bipolar metachromatic granules.

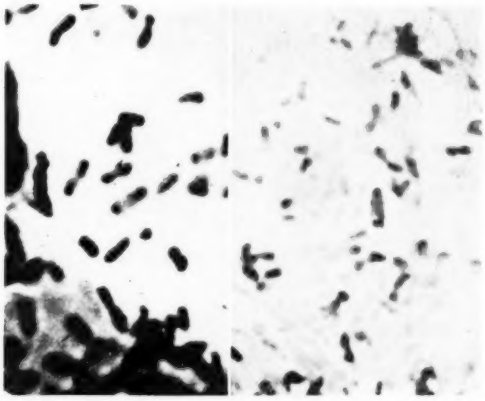


Fig. 3. Organism isolated from the lesion produced in the rabbit's foot. Note the bipolar metachromatic granules.

Fig. 4. Organism isolated from the lesion produced in the calf of leg of Case 1. Note the bipolar metachromatic granules.

the feet of Rabbits 1, 3, and 4 (Fig. 3). Rabbit 2 died 3 weeks after inoculation and though no gross lesion appeared on the feet, microscopic sections showed early thrombosis of the vessels (Fig. 5). In all three rabbits, the lesions appeared on the left extremity, a peculiarity of distribution similar to that observed in thrombo-angiitis obliterans.

Second Stage

From these experiments, one readily notes that the organism grows most favorably in the presence of hæmolyzed blood (blood hæmolyzed by the herudin of the leech) and is activated by the solid contents of blood. An area of skin over the ankle of the affected limb was aseptically prepared and one of the veins punctured. Blood was caught in a sterile test tube containing about 1 cubic centimeter of sterile distilled water, thus making about 3 cubic centimeters in all. After shaking the contents, it was allowed to incubate about 4 hours at the room temperature, so as to effect as nearly a complete hæmolysis as is possible and thus substitute the action of herudin. The contents was then emptied into a sterile bouillon media under the most rigid aseptic precautions and allowed to incubate for 24 hours. The organism derived from this culture was morphologically identical with that of the original organism described, and its cultural characteristics similar in every way. Two other cases suffering with thrombo-angiitis obliterans had submitted themselves for blood culture from the local area, and executed in the same fashion. The organism described proved positive in both.

Third Stage

The same three cases of thrombo-angiitis obliterans and two additional ones were then subjected to the following procedure: The bend of the elbow was thoroughly cleansed with soap and water, followed by a bichloride compress, dried with sterile gauze and painted with iodine, which in turn was washed off with alcohol and dried. A needle previously sterilized in the autoclave was inserted into the median basilic vein and under the most rigid aseptic precautions, 10 cubic centimeters of blood was drawn into a sterile syringe (sterilized in the autoclave) and half of it injected into a sterile bottle containing sterile distilled water and beads. The other half was emptied into a sterile bottle containing beads. Both were shaken for 5 minutes and then emptied into agar media, after being cooled off to a temperature of 42° C., and this in turn emptied into sterile petri dishes in the form of a blood

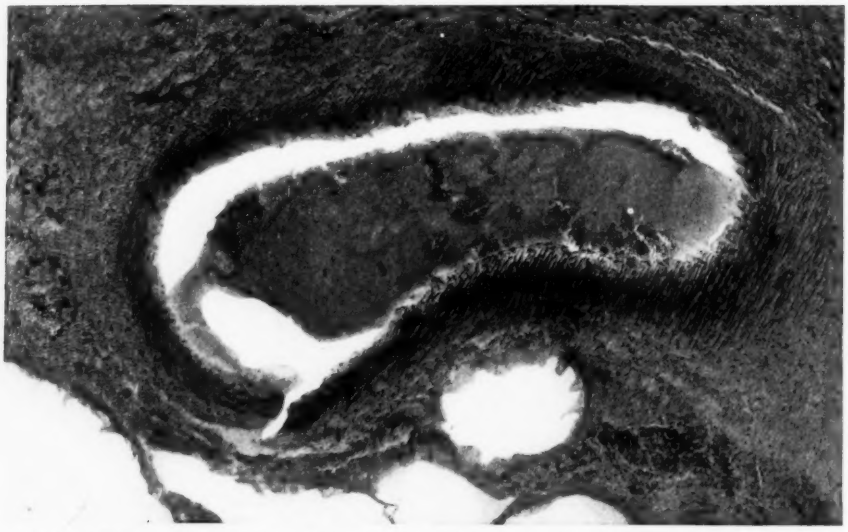


Fig. 5. (Rabbit 1.) Obliterating thrombus with beginning organizing of clot adherent to intima.

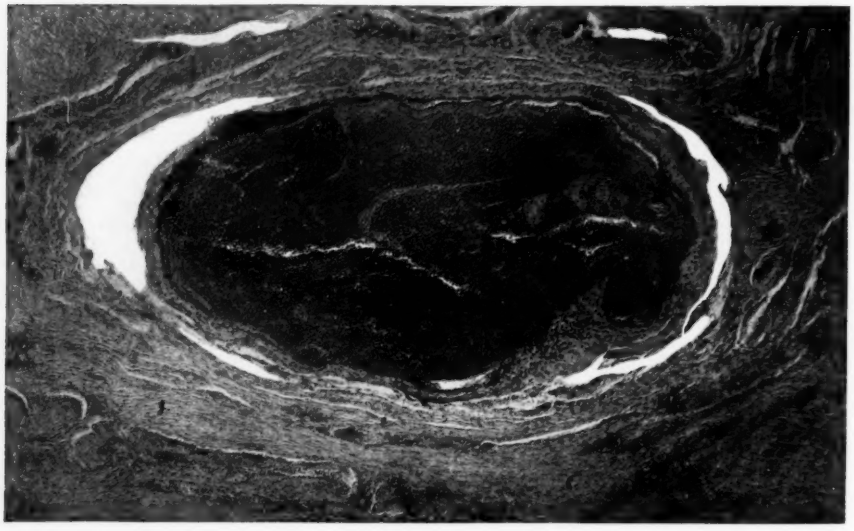


Fig. 6. (Rabbit 3.) Organized thrombus within blood vessel canalized by clefts. Note the capillary sprouts to the right.

agar plate. In all 5 cases a positive culture was obtained on the agar plates containing hæmolyzed blood, after 48 hours' incubation. The colonies, though not abundant, took on a brownish discoloration surrounded by a lighter area of hæmolysis and attained a size of from 0.5 to 1 millimeter. From these colonies, hanging drops were made and studied for motility and then stained. Cultures from these colonies were transferred to Loeffler's

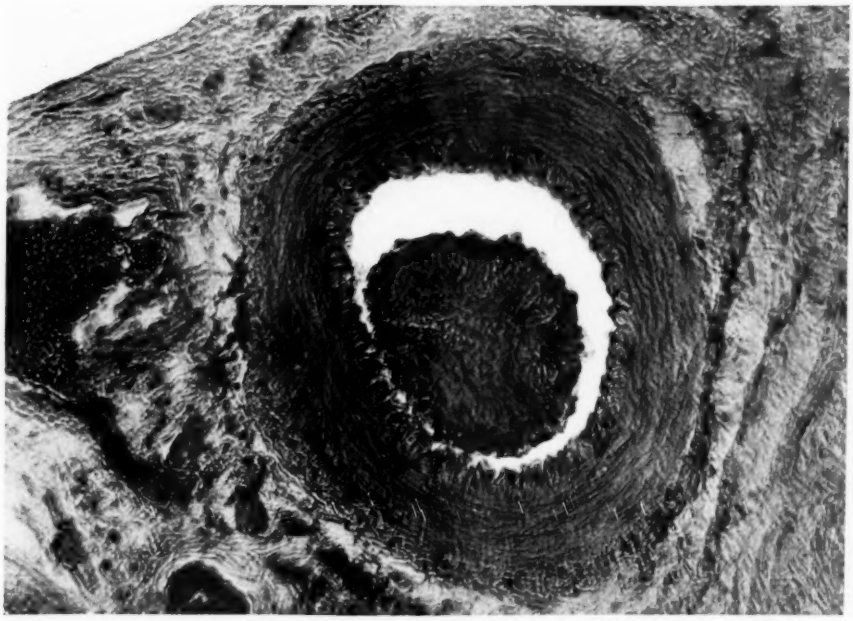


Fig. 7. (Rabbit 3.) Old organized obliterating thrombus.

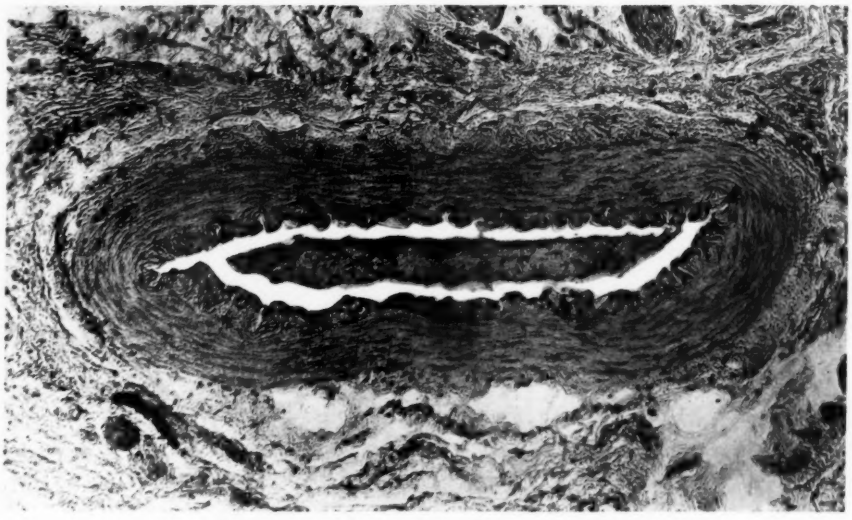


Fig. 8. (Rabbit 4.) Old fibrotic obliterating mass.

tubes, glucose agar slants and agar plates, also glucose, lactose, saccharose, and mannitol broth and their cultural characteristics noted. In all these, the organism was identical, both morphologically and culturally, to that described in the original experiment in Case 1

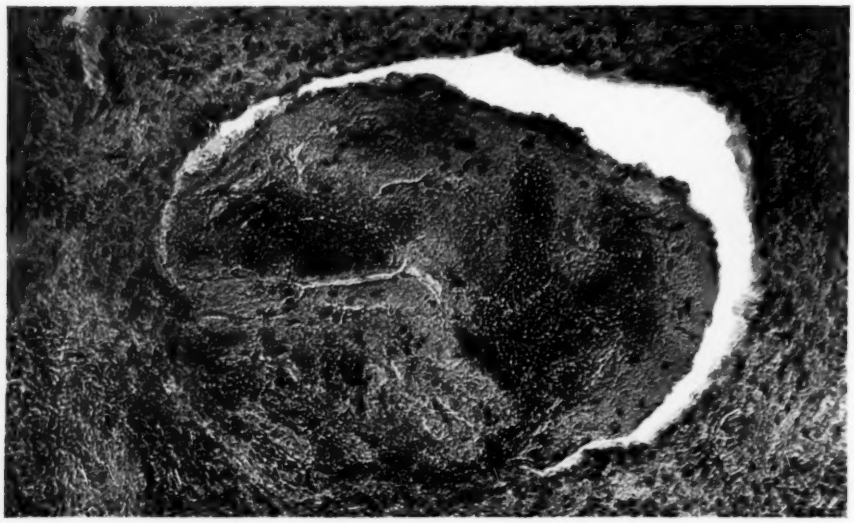


Fig. 9. (Rabbit 4.) Note the organization, vascularization, and canalization.

(Fig. 4). A pure culture of this organism derived from the blood of Case 4 injected into the inner surface of the ear of a rabbit produced a gangrenous lesion identical to that described in Rabbits 1, 2, and 4. The lesion appeared 7 days after inoculation, and further investigation as to remote lesions at a later date will be reported.

CONCLUSIONS

The following conclusions have been arrived at, to be checked up by additional blood cultures:

1. The bacillus isolated produced the same lesion in the ears and feet of the rabbit as that which was present in the calf of the leg of the human being.

2. The lesions produced were similar in their gross and microscopic pathology to that produced in the disease known as thromboangiitis obliterans.

3. This bacillus was isolated both from the blood of the local affected portion and from the general blood stream.

4. The organism was distinctly hæmaglobinophilic.

5. The bacillus could not be isolated from the body of the leech, therefore eliminating the normal habitat of this organism within the leech.

6. Normal hæmolyzed serum (per leech) produced no lesion in the rabbit's ear. The bacillus was therefore responsible for the production of the gross lesions.

7. The clear non-hæmolyzed serum derived from the unaffected veins of the elbow in the specified case, produced no lesion in the rabbit's ear. May I venture this explanation: that the bacillus requires hæmolyzed blood for cultivation and isolation from the blood stream.

8. Though a bouillon culture produced considerable reaction in the ear of Rabbit 4, the culture containing the solid content of blood, activated the bacillus sufficiently to produce a typical gangrenous lesion in the other ear of Rabbit 4.

9. The appearance of lesions on the plantar surfaces and toes of three rabbits, 5 weeks after inoculation, showed conclusively the entrance of this organism into the general blood stream and, furthermore, a specific tissue predilection.

10. The organism isolated in pure culture from the blood of Case 4 produced a similar gross lesion in the rabbit's ear.

I. FIBROMYOMA OF THE EPIDIDYMIS II. PARAFFINOMA OF THE PERITESTICULAR TISSUES[1]

By JOSEPH S. EISENSTAEDT, S.B., M.D., F.A.C.S., Chicago
Associate Surgeon, Department of Genito-Urinary Surgery, Michael Reese Hospital; Associate, Department of Genito-Urinary Surgery, Northwestern University Medical School

THE two cases which I desire to call to your attention are of interest, the one by virtue of its extreme rarity, the other by reason of its unusual location.

I. FIBROMYOMA OF THE EPIDIDYMIS

In a diligent search of the literature I was unable to find record of any solid tumor of the epididymis, with the exception of a case reported by Stout before the New York Pathological Society and published in its *Proceedings* for 1917. His case, however, is that of a small tumor of the epididymis, a trifle over 1 centimeter in diameter. The pathology is reported as that of a fibromyoma, but was first diagnosed as an adenocarcinoma. The patient was a carrier of a primary carcinoma of the gall bladder. This case must be regarded as a doubtful one of fibromyoma.

Winiwarter in volume iii of the *Handbuch der Urologie* quotes Wilms as stating that myomata, both leiomyoma and rhabdomyoma of the testis, may occur and that they have their origin in the so-called cremaster internus, in the muscular sheath of the epididymis, or in the gubernaculum testis. This reference is the only allusion in the entire literature which was at my command as to the possible histogenesis of these tumors. No other reference was found to any primary or metastatic solid tumor of the epididymis. I have asked several pathologists in this city for references or possible reports of cases personally observed and they have not been able to recall any.

Our patient was a man, age 65, admitted to the Michael Reese Hospital to the service of Dr. Kolischer February 23, 1920; No. 16213. He complains of a hernia of left inguinal region and a swelling of left testis. The hernia had been operated upon 2 years before (1918) with subsequent recurrence. The swelling within the left side of scrotum began after the herniotomy in 1918, and has steadily increased to its present size. The tumor is painless but on account of its weight and the "dragging" sensation produced, gives the patient much discomfort when he walks.

The patient's father died at 60, cause unknown; the mother is alive and well; three children are living and well; six children died in infancy or childhood, cause unknown.

Patient's appetite is good; bowels are only fairly regular. He sleeps well and has no difficulty in urination.

Patient had a herniotomy performed 2 years ago; had grippe 3 weeks before entrance.

General physical examination reveals a man in good condition for his years. Findings are negative except for a moderate left inguinal hernia and a tumor within the left half of the scrotum. What is apparently the left testis is felt as a tumor the size of a large goose egg. Its consistency is hard, and there is no tenderness on palpation. Light is not transmitted through the tumor. One is impressed by the marked heaviness of the organ. The tumor ends abruptly at its upper margin and the globus major of the epididymis seems to be involved.

Tentative diagnosis: tumor of left testis, probably malignant.

The Wassermann reaction using cholesterinized, lipoid and syphilitic antigens was frankly negative.

Operation. A typical castration of the left testis and epididymis, with high amputation of the cord, was done. A hard nodule the size of a small almond was palpated in the tissue of the spermatic cord. This nodule was of the same consistency as the larger tumor.

The patient made an uneventful recovery and left the hospital well on the sixth day of March. The specimen was immediately sent to our pathologist, Dr. O. T. Schultz, to whom I am indebted for the pathological report.

Gross pathology. The specimen is 9 centimeters long and 4.5 centimeters in diameter. A small amount of fluid is present beneath the tunica vaginalis. The testis is a sharply defined, encapsulated mass at the lower pole of the specimen; its cut surface is 4 by 1.5 centimeters. Above the testis the epididymis is transformed into a mass of dense, firm, pale, somewhat lobulated tissue, the cut surface of which measures 4 by 4.5 centimeters. At the upper pole the tissue of the cord contains a nodule of similar appearance.

Microscopic examination. The mass is composed in places of bands and large areas of fibrous tissue, which is dense, hyaline, and poor in nuclei; in places this tissue is œdematous. Between the islands and bands of fibrous tissue are more cellular areas, some of which are composed of closely placed, elongated,

[1] Read before the Chicago Urological Society, January 25, 1923. From the Department of Genito-Urinary Surgery and the Nelson Morris Memorial Institute for Medical Research of the Michael Reese Hospital.

Fig. 1. Fibromyoma of the epididymis, approximately natural size. Note the testis displaced and compressed at the lower pole of specimen.

spindle cells of the smooth muscle type. These are usually arranged in interlacing bundles. Other cellular areas are made up of shorter, broader cells, many of which have giant, hyperchromatic, single or multilobulated nuclei. These cells have the characteristic morphology of proliferating smooth muscle cells; the immaturity and cellularity of these islands of tissue are such as to raise a suspicion of beginning malignancy. The more cellular tissue in places is diffusely infiltrated by considerable numbers of lymphocytes. In some of the denser fibrous tissue the small vessels are surrounded by narrow zones of lymphoid infiltration. The mass is covered by a rather thick capsule of dense fibrous tissue. Beneath this are scattered islands of cellular infiltration, composed of lymphocytes and plasma cells which surround newly formed blood vessels. No tubules and no heterologous elements are seen anywhere in the tumor tissue. Outside the capsule are large blood vessels, adipose tissue, and muscle bundles.

Diagnosis: fibromyoma of epididymis.

The patient is at present alive and well with no recurrence of the lesion.

We have, therefore, under consideration a solid tumor of the epididymis which microscopically is benign and which after 23 months has shown no tendency to recur or metastasize, a fibromyoma. The histogenesis of the tumor is not absolutely certain, but in all probability is from the muscular elements of the epididymis.

From the clinical side, the tumor was not differentiated from a new-growth of the testis and the actual testis was mistaken for globus major of the epididymis. As far as the writer is able to determine, this is the first tumor of its kind on record.

II. PARAFFINOMA OF THE PERITESTICULAR TISSUES

A paraffinoma is a foreign body granuloma produced by an unabsorbable oil. Most of those reported, and the number has been quite large, occurred in the tissues of the face, paraffin having been injected by quack cosmetic doctors with the idea of obliterating blemishes of various kinds. The pathology of this entire group is very similar, in fact, almost constant. Paraffins having melting points between 55 degrees and 65 degrees C. are most often used.

Heidingsfeld found the epidermis to be normal. The affected area was encapsulated in a wall of fibrous connective tissue. Near the center was usually one, sometimes several, large cavernous spaces, which were surrounded in satellite form by innumerable small round cavities of similar character, giving the area a sort of honeycomb appearance, not unlike that presented by a well-aerated piece of Swiss cheese. The remainder of the mass resembled in its general appearance a granuloma; showing a variable number of giant cells.

Our patient was a young man, M. R., age 22 years, a clerk by occupation. He was admitted to Michael Reese Hospital to the service of Dr. L. E. Schmidt on April 5, 1921; No. 26712. Patient com-

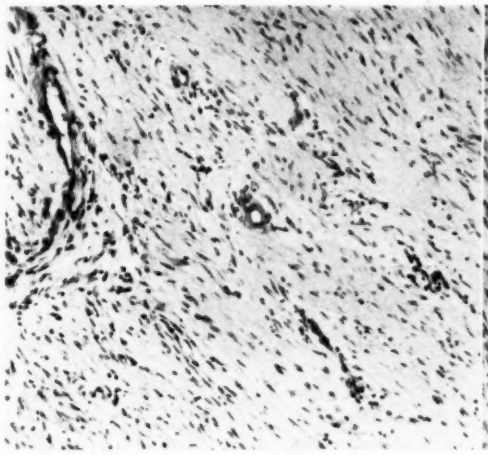


Fig. 2. Section of fibromyoma of epididymis showing the more fibrous part of tumor which is poor in nuclei. ×110.

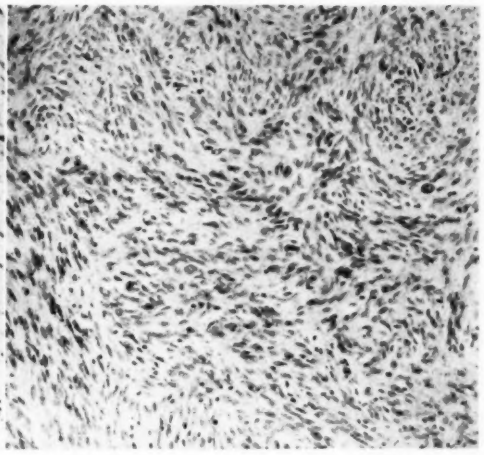


Fig. 3. Section of fibromyoma of epididymis showing large spindle-shape nuclei characteristic of immature or proliferating smooth muscle cell. ×110.

plains of swelling within the scrotum and pain in right leg. In 1918 while in a hospital in Russia, suffering from typhoid fever, some oil was injected into his scrotum. The patient states that this was done by mistake, the injection having been intended for another patient in the ward. Following this injection (interval not stated) the scrotum began to swell, and there was some pain. Since then the condition has gotten progressively worse. Pain in right thigh when walking began a year ago; and it is largely for this reason that patient enters hospital. When he rests there is no pain felt.

Patient has had the usual diseases of childhood and typhoid fever 3 years ago. He had not been operated upon for any condition. Patient denies all venereal disease.

Patient's father died of some renal disease; the mother living and well; one brother is living and well. There is no family history of tuberculosis, carcinoma nor organic heart disease.

General physical examination. The patient is a well-nourished young man apparently 21 or 22 years of age. He is highly neurotic, and ill at ease in his surroundings. He cannot speak nor understand English and cannot speak any of the foreign languages which the house staff commands. Communication was through an interpreter. There is a marked accentuation of all the reflexes. With the exception of the lesion within the scrotum and a right inguinal hernia, special physical examination is negative.

The penis is negative for scar and discharge. There is a hard, smooth tumor mass within the scrotum, the size of a lemon, which does not, however, involve either testis, as these organs can be distinctly differentiated from it. The normal testicular consistency is noted on palpation as well as the characteristic pain when the testes are compressed between thumb and index finger.

Laboratory examinations of urine and blood were negative. The Wassermann reaction was negative with all three antigens.

Operation. An incision was made in the right anterior surface of the scrotum, and a hard solid tumor intimately attached to the tunica vaginalis of the right testis and epididymis, and infiltrating all the enveloping tissues, including the derma, which were with difficulty dissected away from the testis and epididymis, entirely sparing these structures. The infiltrating tumor mass including a narrow strip of skin was removed. The wound was sutured with interrupted silk sutures and gutta percha drainage left in the lower angle of the wound. The hernia was repaired according to the typical Bassini technique.

The pathological report by Dr. O. T. Schultz is as follows:

Gross specimen. An irregular mass 7 by 7 by 4 centimeters composed of a main ovoid portion 6 by 3.5 by 3.5 centimeters, to one surface of which a piece of skin 6 by 1.5 centimeters is closely adherent. This mass is very firm, yellowish grey, with a central cavity 1 centimeter in diameter. It is well defined and is covered by a closely adherent fibrous capsule. Attached to this larger mass is a second, firm, flattened mass 3.5 centimeters in diameter and 1.5 centimeters thick. This likewise is yellowish grey in color, but is not sharply defined and is surrounded by a thick layer of dense fibrous tissue. Attached to the latter is a flattened cord-like structure 4.5 centimeters long by 3 by 1 centimeter. This contains two small hard nodules.

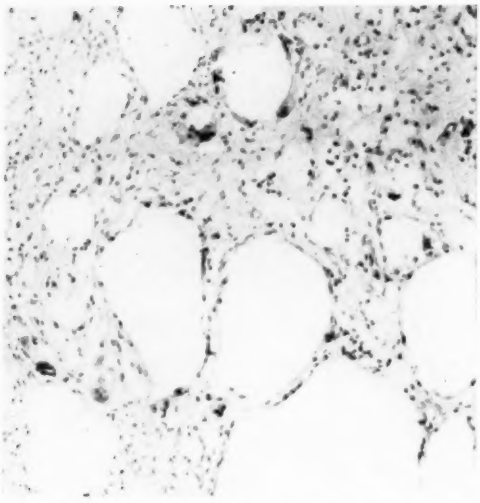


Fig. 4. Paraffinoma of peritesticular tissue, showing numerous cavernous spaces separated by narrow stroma bands. Note also giant cells in connective tissue of granuloma type. ×110.

Microscopic examination. Sections from the main mass, the large accessory nodule, and the small nodule in the cord-like structure are all similar. Areas of varying size are made up of groups of clear spaces which are separated from each other by narrow stroma bands. These areas have the appearance of adipose tissue, but the spaces are larger and vary more in size than those of normal fat. These areas are scattered about irregularly in a very dense, hyaline fibrous tissue which is poor in nuclei. In this tissue are a few scattered, sharply defined bundles of elongated fibers which have the appearance of smooth muscle. In the tissue made up of the clear spaces there are a few small collections of lymphocytes. A few of the spaces are partly surrounded by multinucleated syncytium of the foreign body, giant-cell type. There is no active proliferation and nothing to cause any suspicion of malignancy.

Diagnosis: foreign body granuloma of peritesticular tissue (due to unabsorbable oil).

This case is detailed chiefly because in the writer's memory no such case has been reported before this society and to call attention to the severe, if not serious, reaction which may and not infrequently does follow the injection of unabsorbable oils into the body. In the latter sense, it has a bearing on the selection of vehicles for the exhibition of insoluble mercurial preparations in the treatment of syphilis.

To the dermatologist these lesions are by no means rare but they should not be the only ones to be familiar with the condition. The diagnosis in the presence of a good history is easy and the only treatment is surgical ablation.

THE ETIOLOGY AND IMPORTANCE OF THE CYSTICO-DUODENO-COLIC FOLD[1]

By GUNTHER W. NAGEL, M.D., Rochester, Minnesota
Fellow in Surgery, Mayo Foundation

CERTAIN congenital anatomical variations in the peritoneal relations of the gall bladder have not received the attention they deserve from the anatomist, clinician, or surgeon; I refer to folds occasionally found extending from the fundus of the gall bladder to the duodenum and transverse colon.

Standard anatomies dismiss these ligaments with a few words or fail to mention them. Figure 1 (Spalteholz) shows the usual anatomical relations in the gall-bladder region. Spalteholz says that there is often a fold from the under surface of the gall bladder to the descending part of the duodenum or the transverse colon. Cunningham speaks of an occasional fold passing from the region of the gall bladder to the transverse colon and right colic flexure. Piersol says that the lesser omentum is sometimes described as being prolonged across the first part of the duodenum to the transverse colon, fusing there with the great omentum, and he adds that while common, this is only an accidental finding. He also describes an accessory fold, the duodenocystic ligament, which is prolonged to the right from the front of the lesser omentum in the region of the cystic duct and gall bladder.

Testut and Belou describe and illustrate the ligament as extending from the superior border of the transverse colon to the upper extremity of the gall bladder. Henle, among the older anatomists, gives a somewhat diagrammatic picture of a ligament extending up over the liver and fundus of the gall bladder and reaching down as far as the transverse colon, but he does not describe it in his text. Deaver also illustrates, but does not describe, the ligament. Toldt pictures an unusual fold in the body of an infant, 3 weeks old, in which the ascending and transverse colons had failed to adhere to the posterior abdominal wall, the ligament in question extending from the gall bladder to the parietal peritoneum to the right of the ascending mesocolon. Morris discusses peritoneal folds in general and says that variations due to extensions of normal developmental processes are difficult to distinguish from pathological adhesions. Kehr quotes Konjetzny as drawing attention to a ligament binding together the transverse colon and gall bladder. Konjetzny ascribes more or less importance to it and asserts that it may produce symptoms simulating gall-bladder disease sufficiently severe to justify operation. He adds that, while congenital in origin, it may become secondarily indurated from purely mechanical causes, as, for example, tension caused by a sagging transverse colon. Kehr says that these bands are merely a widening of the hepatoduodenal ligament, and are of very little importance.

The accessory folds that I found are prolongations of the lesser omentum onto the under surface of the gall bladder, extending to the right across the duodenum and downward to the transverse colon where they become continuous with the anterior layer of the great omentum. In order to understand their anatomical relations and possible variations, it is essential to trace their mode of formation in the embryo.

In human embryos of about 6 weeks the intestinal tract consists of a partially differentiated tube suspended in the cavity of the body throughout its entire length by a dorsal mesentery, and a ventral mesentery which divides the upper portion of the cavity and ends in a free margin extending from the region of the umbilical cord to the juncture of the fore and mid gut. Just below the free attachment of the ventral mesentery is the primary intestinal loop, in the lower limb of which the cæcum develops. The liver, gall bladder and ducts develop between the folds of the ventral mesentery from outpocketings of the foregut (Fig. 2). The portion of the

[1] Work done in the Section on Pathologic Anatomy at the suggestion and under the direction of Dr. H. E. Robertson.

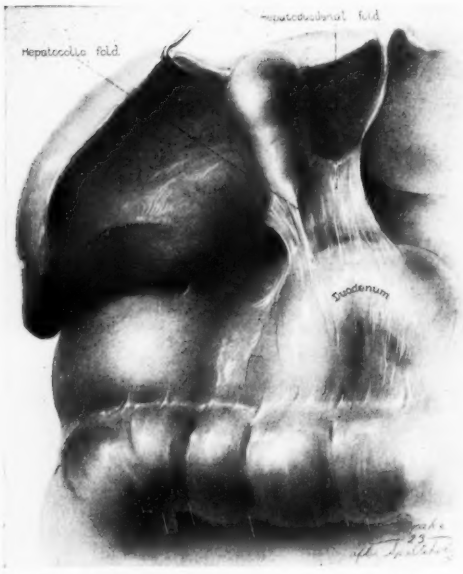


Fig. 1. Normal peritoneal relations of the gall bladder. (Spalteholz.)

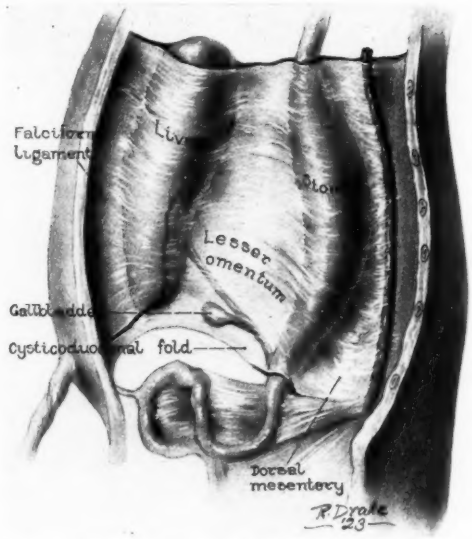


Fig. 2. Semidiagrammatic drawing showing the development of the liver, gall bladder and ducts within the folds of the ventral mesentery, and illustrating the formation of the cystico-duodenal fold. (Modified from Kollmann.)

ventral mesentery lying between the liver and stomach becomes the lesser omentum while the fold between the liver and anterior abdominal wall forms the falciform ligament. The lesser omental sac is represented in 3 millimeter embryos by a small pocket extending into the dorsal mesentery to the right of the œsophagus. A longitudinal ridge makes its appearance to the right of the opening of this sac along the dorsum of the body cavity, the plica vena cava, in which the vessel of that name develops. The liver grows rapidly in three planes and, spreading the leaves of the ventral mesentery apart, forms a crescent on cross section, the right free margin of which with the plica vena cava forms a partition between the lesser omental sac and the peritoneal cavity. In 5 to 10 millimeter embryos the omental bursa is semilunar in cross section and is bounded on the left by the great omentum (dorsal mesentery) and right wall of the stomach, on the right by the liver and the plica vena cava, and ventrally by the lesser omentum (ventral mesentery). The bursa communicates with the peritoneal cavity through an opening between the liver ventrally and the plica vena cava dorsally, the future foramen epiplocium (Fig. 3). The stomach now rotates in two directions; clockwise on a fulcrum lying anteroposteriorly, bringing it nearly to a transverse position, and on its longitudinal axis so that the former left wall becomes its anterior, and the right wall its posterior surface. The lesser peritoneal sac now lies under the stomach and that part of the dorsal mesentery which formed its left boundary continues to grow out over the transverse colon, at first as an open pocket which later closes by fusion of its two contiguous surfaces, then becoming adherent to the transverse colon to form the great omentum (Fig. 4). With these changes there is rotation of the small and large bowels, the cæcum traveling from the lower left quadrant across the duodenum to the upper right quadrant directly under the right lobe of the liver, then slowly descending to its normal adult location near the brim of the pelvis. The small intestine rotates around the superior mesenteric artery as an axis, and its mesentery becomes attached to the posterior abdominal wall along a line extending diagonally

from above downward and from left to right. The duodenum, the ascending and descending colons fuse with the posterior abdominal wall, their mesenteries becoming obliterated, the condition found in the adult (Figs. 5, 6, 7 and 8). The lesser omentum now lies on a coronal plane, its anterior layer being continuous over

TABLE I.—MAYO CLINIC CASES

Case	Age, sex	Data from cases	Other congenital abnormalities
A304679	40 M	Malignant osteoma of left parietal bone.	
A400979	M	Stillborn, eight months, cleft palate, harelip, patent interventricular sentum, mobile cæcum and ascending colon; webbed fingers of left hand, hypospadias.	See Column 3
A400507	31 M	Chronic aortic and mitral endocarditis with cardiac dilatation and hypertrophy; foramen of Winslow closed.	
A401367	33 M	Fractured skull (suicide).	Meckel's diverticulum.
A403207	37 M	Diphtheria, œdema of larynx and lungs.	Cæcum in right upper quadrant
A399664	50 F	Hyperplasia and adenoma of the thyroid, cardiac hypertrophy.	
A208764	56 F	Recurrent exophthalmic goiter with cardiac hypertrophy and dilatation.	
A394327	45 M	Chronic myocarditis with hypertrophy and dilatation.	
A333504	45 F	Myelogenous leukæmia, splenomegaly, hæmorrhage into left cerebrum; foramen of Winslow closed.	
A392722	32 F	Exophthalmic goiter, thyroidectomy, cardiac hypertrophy.	
A119472	30 M	Malignant papilloma of bladder, cystitis, and pyonephrosis.	Accessory spleen.
A404586	45 M	Exophthalmic goiter, thyroidectomy, bronchopneumonia with multiple abscesses.	
A405083	38 F	Cystic glioma of left frontal lobe, terminal pneumonia; foramen of Winslow closed.	
A354664	48 M	Ulcerating squamous-cell carcinoma of face and neck.	Accessory pancreas in jejunum.
A112491	F	Prematurity, 8 months, partial fetal atelectasis, punctate hæmorrhage in pia arachnoid.	
A367384	60 M	Carcinoma of prostate, septic infarcts of lungs, early bilateral empyema, cysto-uretero pyelo nephritis, septic jaundice.	
A110558	4 F	Glioblastoma of the right eye, enucleation.	
A112224	74 M	Coronary sclerosis with myocarditis, cardiac hypertrophy and dilatation.	Diverticulum of duodenum, short mesentery to ascending and descending colons

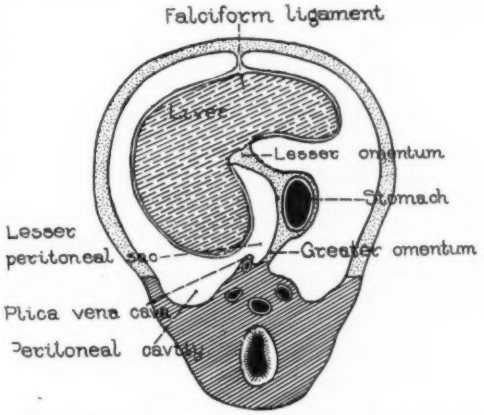


Fig. 3. Diagrammatic drawing showing the formation of the lesser peritoneal sac in an embryo of about 10 millimeters.

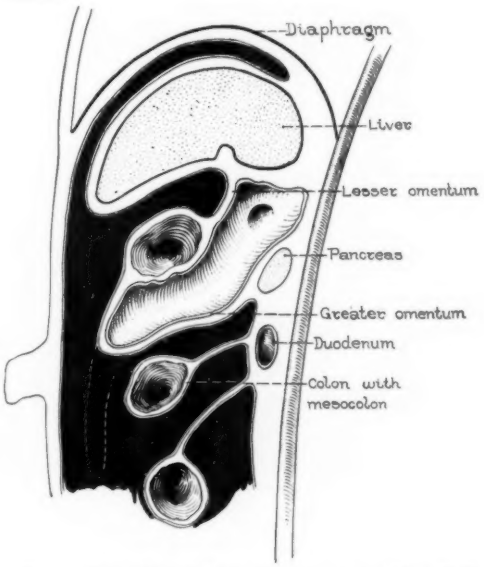


Fig. 4. Formation of the great omentum. (After Kollmann.)

Summary of Table I	Cases	Per cent
Cases examined	150	
Cases of general type seen in Figure 9	16	
Cases of type seen in Figure 10	2	
Cases with ligaments as described	18	12
Cases in which foramen of Winslow was closed	3	16.6 of 18
Cases showing other congenital defects	6	33.3 of 18
Average age, years	37.6	
Males	11	61.1
Females	7	38.8

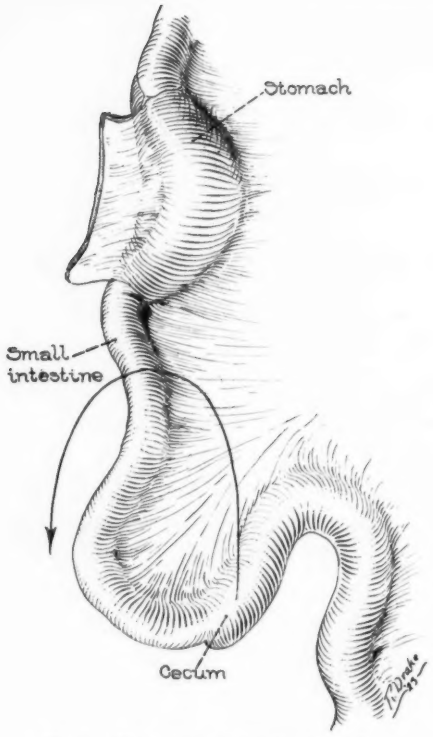


Fig. 5. First stage of intestinal rotation.

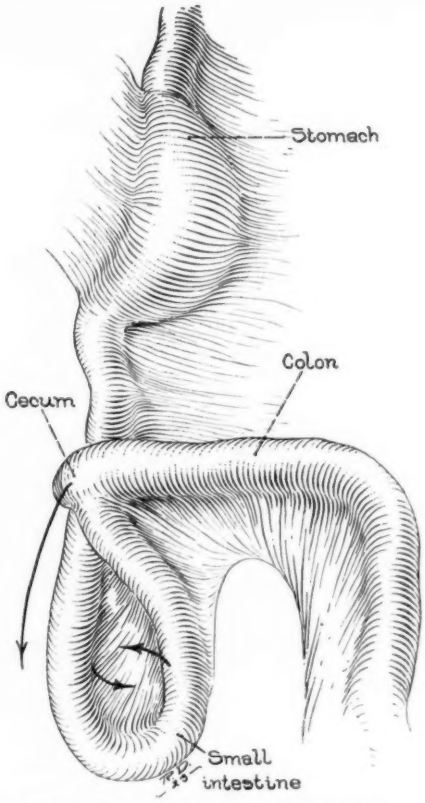


Fig. 6. Second stage of intestinal rotation.

the stomach with the anterior layer of the great omentum and thus in direct contact with the transverse colon. The foramen of Winslow is bounded ventrally by the free edge of the lesser omentum, dorsally by the inferior vena cava, cranially by the liver, and caudally by the duodenum. An extension of the lesser omentum, a variable distance to the right, explains the accessory folds as we find them. The point at which the free margin of the ventral mesentery (Fig. 2) crosses the intestinal tract, and its persistence caudad to the common bile duct determines the extent of the fold. That this point may vary seems obvious.

Virchow, in 1853, discussing chronic adhesions, mentions specifically the frequent attachment of the right colic flexure to the under surface of the liver and gall bladder and speaks of anomalous bands from the latter viscus to the pylorus and duodenum, evidently referring them, however, to a chronic, localized peritonitis. Morris was the first in this country to draw attention to these folds, describing them picturesquely as "cobwebs in the attic of the abdomen"; and he also attributed them to inflammatory processes.

Harris, Hamann, Homans, and others, report cases in which the symptoms led to a diagnosis of chronic cholecystitis, cholelithiasis, or duodenal ulcer, but which at operation showed only abnormal folds, undoubtedly of embryological origin, extending from the gall bladder to the duodenum or transverse colon, simple sectioning of which afforded permanent cure in the majority of instances. Homans found that combining sectioning of the ligament with a Finney pyloroplasty gave the best results. The majority of patients are

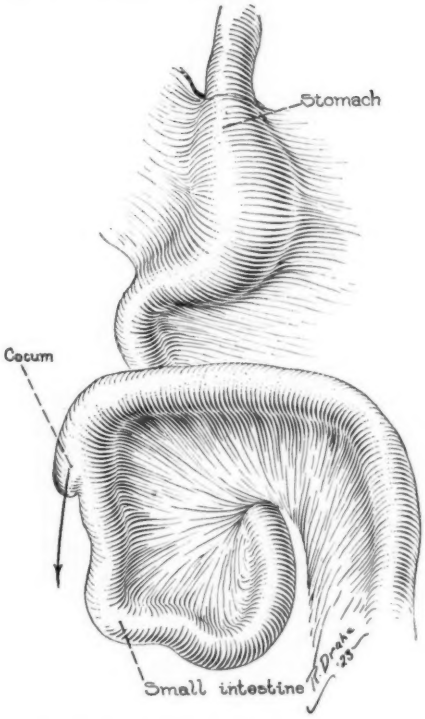


Fig. 7. Third stage of intestinal rotation.

middle aged, and almost all the complaints are long standing and consist of indefinite symptoms such as sour stomach, fulness, and gaseous eructations, epigastric discomfort with dull, constant pain and occasional knife-like exacerbations. Sometimes slight relief is afforded by a moderate meal. Cole describes the roentgenographic findings in similar cases and emphasizes their importance in that they may simulate gall-bladder disease. Roentgenograms may show a partially constricted or compressed cap, the left superior surface of which has a thin, feathered-out appearance while the right side is clear cut. The deformity is most marked when the patient is in the erect or prone position and often is absent when he lies on the right side. Hubeny describes similar cases which have an elongated or dilated caput, fairly well defined with moderate fixation at the juncture of the first and second portions of the duodenum.

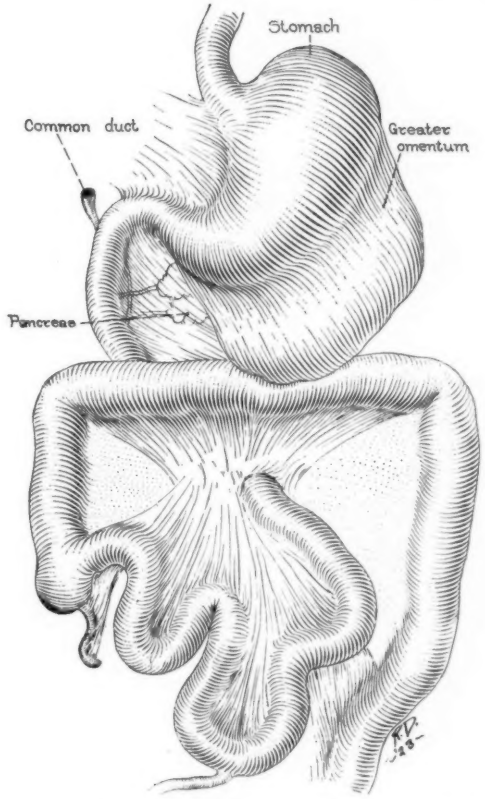


Fig. 8. Intestinal rotation completed. (After Kollmann.)

Moynihan describes a more unusual form of ligament found in some patients with vague dyspepsia, who, at operation show a membranous band, differing from Jackson's veil, broad above where it takes origin from the posterior abdominal wall, the under surface of the liver, the pelvis of the gall bladder, the cystic duct and duodenum, and narrowing below as it crosses the ascending colon to be lost on the parietal peritoneum. Below this band the cæcum and ascending colon are distended and soggy, the appendix often appears thick and stiff; the cæcum, ascending colon and terminal ileum in such cases require resection.

Harvey treats the entire subject of peritoneal folds and ligaments at length and re-

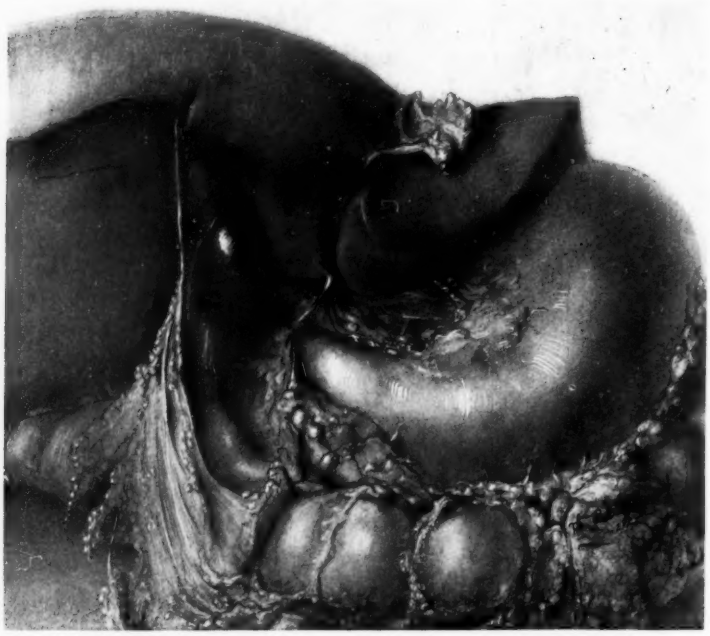


Fig. 9. (Case A354664.) Well-marked cystico-duodeno-colic ligament.

views the literature. He publishes a table showing the percentage of cases in which a cystocolic ligament has been found by various workers.

TABLE II—CASES REPORTED IN THE LITERATURE (HARVEY)

	Cases	Per cent
Jonnesco	100	25
Addison	40	30
Mollison and Cameron	50	20
Buy		25
Bricon	89	15
Reid	20	30
Leveuf	50	28
Ssabslow	145	23
Harvey	105	18
Testut (Quoted by Kehr)	100	16

Ancel and Sencert (Kehr) found the ligament well developed in 48 per cent of cases and in some instances it completely closed the foramen of Winslow. The ligament has been found a number of times in fetuses and the newborn. Brewer reports 3 per cent of 100 cases in which a cystocolic fold extended over the fundus of the gall bladder. Harvey, in his series, recorded only those cases in which the ligament extended up the gall bladder more than one-third its length. Of the twenty subjects twelve were male and eight were female. Thirteen specimens were examined histologically and showed no evidence of infection.

A ligament was found extending from the gall bladder to the duodenum and colon in eighteen instances (12 per cent) of 150 consecutive necropsies at the Mayo Clinic. Only those cases are included in which the ligament extended at least half way up the fundus (Fig. 9, 16 cases) or where it existed as a continuous fold from the lesser omentum across the duodenum to the hepatic flexure of the colon (Fig. 10, 2 cases). In structure and appearance the ligaments were identical with the lesser omentum, all forming a direct continuation of it. They consist of veils of delicate, semi-transparent membrane containing variable amounts of fat, especially near their attachments. In the type shown in Figure 9 the ligament was usually attached with mathematical accuracy in a line parallel with the long axis of the viscus, over a base not more than 2 or 3 millimeters in width. The line of attachment was most often mid-

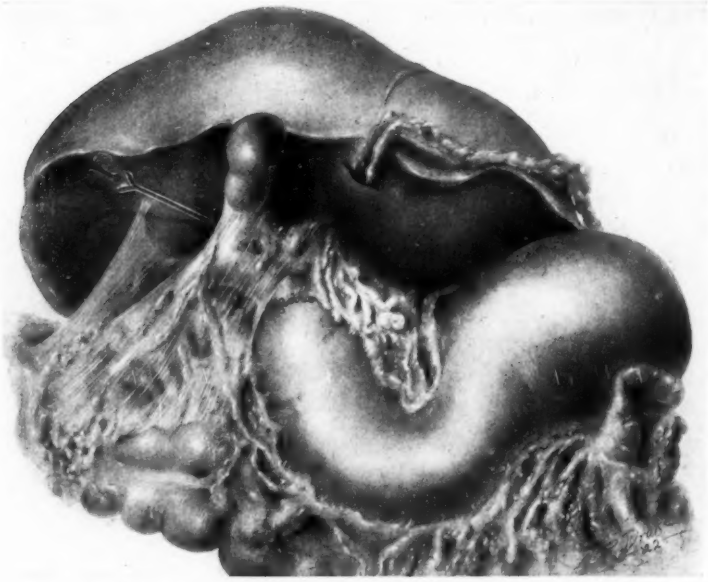


Fig. 10. (Case A119472.) Extension of the anterior fold of the lesser omentum across the duodenum to the right colic flexure.

way between the right and left margins of the organ, but occasionally it was to the right, and once it lay at its extreme right margin where it was reflected onto the surface of the liver. Infection was definitely ruled out as an etiological factor by both gross and microscopical examination of the ligaments and involved organs. In none of them was there the slightest suggestion of old or recent peritonitis. Two of my cases were in premature infants, of 8 months, in which there was no question of infection. In view of the fact that congenital deformities are often multiple, the presence of other developmental anomalies in six instances (33 per cent) is important.

The details of the cases are given in Table I. All the patients showed ligaments of the type illustrated in Figure 9 except Cases A400507 and A119472 which were of the type seen in Figure 10.

The ligament was present in 20 additional cases not included in the table because there were pathological processes present in neighboring organs which might have produced adhesions in the region concerned. Even in these, however, the ligaments were typical and, though somewhat thickened and shortened as a result of infectious processes, were undoubtedly congenital in origin. Inclusion of these would make 25.3 per cent of positive cases which compares more favorably with the findings of other writers previously listed.

Only two of the patients complained of gastric symptoms and in each these could be well explained on some other basis. The patient in Case A401367 had indefinite epigastric distress and dyspepsia for 15 years associated with marked constipation, all of which could readily be acccunted for by a chronically infected Meckel's diverticulum. The patient (Case A333504) had epigastric distress and belching after meals for 6 months prior to death, symptoms undoubtedly due to a tremendously enlarged spleen (myelogenous leukæmia). In none of the cases can the presence of the fold be said to have given rise to symptoms, and, taking into consideration the normal variations in position of the stomach, pylorus, and duodenum, it was evident in every case that these ligaments in

no way distorted the appearance of the gall bladder or gut, and with the organs in their normal positions there was no evidence of pulling or tension on the ligaments themselves. However, it is quite conceivable that they might produce symptoms. Figure 9 illustrates how an overfilled or sagging colon could drag on the gall bladder and cause symptoms simulating cholecystitis. The effect of traction on peritoneal surfaces in general is too well known to need further elucidation.

Aside from presenting an interesting variation in the normal anatomy of the gall-bladder region, the ligaments undoubtedly have a practical bearing in their relationship to neighboring pathological processes. With infection or disease in a nearby organ these ligaments thicken and shorten and then may be considered identical with true inflammatory adhesions so far as the production of symptoms and the surgical cure of them is concerned. They are not only potential adhesions themselves but furnish a guide for the formation of true adhesions, much as a trellis or piece of string guides the growth of a vine, and their presence explains why such dense adhesions between gall bladder and gut are found in some apparently mild cases of cholecystitis or duodenal ulcer, as judged by the primary pathological process, while in other apparently more advanced lesions there are few or no adhesions. Finally, it is essential for the surgeon to understand the nature and character of these ligaments in order that they be not mistaken for true adhesions and thus lead to false conclusions and needless or harmful surgery.

CONCLUSIONS

1. A cystico-duodeno-colic ligament is present in a small percentage of persons.

2. The ligament is a part of the lesser omentum and therefore of congenital origin.

3. Under normal conditions the ligament probably produces no symptoms and therefore requires no treatment.

4. The ligament is, however, a source of danger in that it represents a potential adhesion ready to thicken and shorten in response to neighboring pathological processes, and to furnish a guide and stimulus to the formation of true adhesions.

BIBLIOGRAPHY

1. Belou, P. Anatomia de los conductos biliares y de la arteria cistica. Buenos Aires, Imp. Oceana, 1915.
2. Brewer. Quoted by Harvey.
3. Cole, L. G. Veils in the right hypochondrium and their differentiation from other organic lesions and spasm. Am. J. Roentgenol., 1922, ix, 137–148.
4. Cunningham, D. J. Text-book of Anatomy. 3rd ed. New York: William Wood & Co., 1919, 1427 pp.
5. Deaver, J. B. Surgical Anatomy. Philadelphia: P. Blakiston's Son and Company, 1903–1904, iii, p. 183.
6. Hamann, C. A. Faulty rotation of the intestine. Ann. Surg., 1922, lxxvi, 491–495.
7. Harris, M. L. Constrictions of the duodenum due to abdominal folds of the anterior mesogastrium. J. Am. M. Ass., 1914, lxii, 1211–1215.
8. Harvey, S. C. Congenital variations in the peritoneal relations of the ascending colon, cecum, appendix and terminal ileum. Ann. Surg., 1918, lxvii, 641.
9. Henle, J. Handbuch der systematischen Anatomie des Menschen. Braunschweig: F. Vieweg and Son, 1855–1871, i–iii.
10. Homans, J. A study of the symptoms and treatment of congenital transduodenal bands. Boston M. & S. J., 1916, clxxv, 665–673.
11. Hubeny, M. J. An anomalous transduodenal band. J. Roentgenol., 1919, ii, 384–396.
12. Huntington, G. S. The anatomy of the human peritoneum and abdominal cavity considered from the standpoint of development and comparative anatomy. Philadelphia: Lea Brothers, 1903, 292 pp.
13. Kehr, H. Chirurgie der Gallenwege. Neue deutsch. Chir. Stuttgart: Enke, 1913, viii, 8–9.
14. Kollmann, J. Handatlas der Entwicklungsgeschichte des Menschen. Jena: Fischer, 1907.
15. Konjetzny. Quoted by Kehr.
16. Morris, R. T. Gall spider cases. Am. Med., 1905, x, 95–97.
17. Idem. Human Anatomy. 5th ed. Philadelphia: P. Blakiston's Son and Company, 1914, 1539 pp.
18. Moynihan, B. G. A. Disappointments after gastro-enterostomy. Brit. M. J., 1919, ii, 33–36.
19. Piersol. Human Anatomy. 5th ed. Philadelphia: J. B. Lippincott Company, 1919, 2104 pp.
20. Spalteholz, W. Handatlas der Anatomie des Menschen. 7th ed. Leipzig: Hirzel, 1914, iii, 544 pp.
21. Testut, L. Précis—atlas de dissection des régions. Paris: Doin, 1921, 251 pp.
22. Toldt, H. An atlas of human anatomy for students and physicians. New York: Rebman, 1919, iii and iv.
23. Virchow, R. Historisches, Kritisches und Positives zur Lehre der Unterleibsaffektionen. Arch. f. path. Anat., 1853, v, 281–375.

TORSION OF THE SPERMATIC CORD WITH GANGRENE OF THE TESTICLE; REPORT OF TWO CASES

By HAMILTON W. McKAY, B.S., M.D., Charlotte, North Carolina
The Crowell Clinic of Urology and Dermatology

A REVIEW of the literature shows the subject of torsion of the spermatic cord to be both interesting and instructive because the etiology is unknown and the diagnosis is most difficult and frequently not made until operation.

In an article in Surgery, Gynecology and Obstetrics, December, 1919, Dr. Vincent O'Connor finds but 124 cases of torsion of the spermatic cord reported in all the literature, but it would seem from a close study of this condition that it is quite frequent. However, it is generally undiagnosed before operation.

Authors who have studied this condition and reported cases recognize two distinct varieties: the acute type and the recurrent type. Both varieties are often incorrectly diagnosed as epididymitis, orchitis, or strangulated inguinal hernia. A definite diagnosis of strangulated hernia was made in over 50 per cent of the cases where vomiting was present.

ETIOLOGY

Torsion may occur at any age but in the majority of cases it occurs at the age of puberty. Seventy cases have been reported on the right side as against 54 on the left. The various authors agree that torsion is dependent upon two factors:

1. The abnormal attachment of the testicle to the spermatic cord or an abnormally spacious sac formed by the tunica vaginalis in which the testicle is suspended, causing what is called a movable or floating testis;

2. A sudden or violent contraction of the cremaster muscle.

Torsion may occur during rest or following some violent strain. Of the two cases I have seen, one came after jumping on a horse, the other while in the sitting posture.

PATHOLOGY

The twist is usually in the free portion of the cord contained within the tunica vaginalis and usually occurs from without inward. On opening the tunica vaginalis we find a blood-stained fluid or the cavity may be filled with blood clots. The operator is reminded of inspecting the abdominal cavity where he is confronted with either a twisted ovarian pedicle or a ruptured tubal pregnancy. The testicle is reddish blue or black, depending upon the duration.

SYMPTOMS

The subjective symptoms are not unlike those of any inflammatory condition of the scrotal contents and will not, as a rule, lead to a diagnosis *per se*. Pain is a constant symptom, varying in degree and is usually high up in the groin along the course of the spermatic cord.

Nausea and vomiting may or may not be present and can be dismissed as a possible aid to a diagnosis.

Swelling of the scrotal contents with marked œdema extending to the opposite side of the scrotal partition is fairly constant. The shortening of the cord by the twist gives the scrotal contents the appearance of being *pulled up into the groin*. Tenderness is a most important symptom but not as acute as in the infectious processes occurring in this region.

A diagnosis is exceedingly difficult and is very often not made until an operation is performed. The condition is frequently confused with strangulated inguinal hernia or incarcerated omental hernia, and they are excluded with great difficulty. In a differential diagnosis in this region, we usually have to exclude an acute epididymitis because of the frequency of this condition.

The most valuable points of differentiation:

1. Elevation of the scrotal contents as if it were pulled up into the inguinal region;

2. Marked œdema extending across the septum, giving the appearance of encroaching upon the other testicle;

Fig. 1. Lateral view, showing twist in free portion of cord and constriction of circulation.

Fig. 2. Anteroposterior view of cord showing a more definite constriction below twist.

3. *Mild* degree of tenderness as compared with acute infectious processes of the scrotum.

TREATMENT

A few cases are on record where detorsion has been successfully performed when seen within a few hours after onset.

If the testicle can be saved and the circulation is not permanently interfered with, orchidopexy can be done. Eversion of the tunica vaginalis is usually sufficient.

In any case where gangrene, necrosis, or any permanent circulatory obstruction is met, removal of the testicle and as much of the cord as is indicated should be done.

CASE 1. J. M., age 19; a cavalryman by occupation; presented himself at the venereal wards of an army hospital giving the following history: The afternoon before, while on duty, he suddenly jumped from the ground astride his mount. A few hours afterward he felt a pain in the right side of the scrotum which was followed by slight swelling. On admission there was general malaise, no nausea or vomiting; temperature, pulse, and respiration normal. The patient did not look sick. He strenuously denied having had gonorrhœa, syphilis, or chancroid.

The physical examination showed a well nourished and developed boy, normal in every respect except for his local condition in the region of right groin and testicle. At the external urinary meatus there was a sticky, glairy mucous discharge from which smears were made. No cultures were made. The urine was clear except for a few shreds in the first glass. The prostate and vesicles were normal.

Patient was put to bed, an ice cap applied locally, given a liquid diet, and carefully watched.

Laboratory findings: The urethral discharge was reported *positive* for gonococci. Urinalysis was negative.

Pre-operative diagnosis: gonorrhœal epididymitis.

Operation. The scrotal sac was opened in the usual manner. The cord showed a twist of one-half turn with complete obstruction to the circulation and gangrene of the testicle. Orchidectomy was performed. There was a complete and uneventful recovery.

CASE 2. G. H. T., age 34; S. clerk in clothing store. (Reported by courtesy of Dr. Brodie C. Nalle.) The father died at the age of 50 of typhoid fever. The mother died at the age of 61 of pneumonia. Four brothers are living and well. Two sisters are living and well. One brother and one sister died during infancy. There was no history of tuberculosis, malignancy, epilepsy, or insanity in family.

The patient's general health has been excellent. He has never had an illness of sufficient gravity to confine him to bed and has never been in a hospital before. He gives no history of accident, injury, or surgical operation. Patient had gonorrhœa 8 years ago. He was successfully treated and has had no trouble in this connection since. He gives no history of abrasion or sore on penis.

On the night of April 29, 1921, patient was seated on a couch when he was seized with a sudden sharp pain in the left testicle which was rather severe. During the night the pain moved up the left side of the abdomen. He thought the trouble was due to constipation so he took a cathartic with good results but was not relieved of the pain. The pain continually became more severe, and during the afternoon following the onset he noticed some swelling of the left testicle with slight tenderness. There was slight nausea but no vomiting Saturday afternoon (i.e. day following the onset). There was no history of chills or temperature. The day following the onset the patient consulted a physician, who thought his trouble was due to an epididymitis and gave him an ichthyol ointment, which did not give relief. This doctor continued to see him at intervals during the week following the onset of the trouble but the swelling and pain with tenderness seemed to become gradually worse. He had no trouble with constipation during this period. A week from the onset, the patient found temporary relief from cold applications. The swelling and hardness of the left testicle continued and on Saturday night—8 days from beginning of the trouble—Dr. Nalle saw him and advised him to enter St. Peter's Hospital. I saw him the following day (10 days after onset) in consultation with Dr. Nalle.

Physical examination. Showed a well-developed and well-nourished man, apparently normal in every respect except his local condition in the left groin and left scrotal region. There was no spasm, rigidity or tenderness over any portion of the abdomen except in this region and there was no visible peristalsis noted. Urethral discharge was absent. The prostate and vesicles were normal on rectal examination. In the left inguinal region and extending into the scrotum there was a hard mass connected with the testicle which was pulled high

up in the scrotum. The mass could be traced into the inguinal canal but the outline of the testicle and epididymis was obscured.

A tentative diagnosis of torsion of the spermatic cord with gangrene of testicle was made.

Operation. At operation the cord was twisted by rotation upon itself in a clockwise direction. The extent of the rotation was one-half turn. The testicle and that portion of the cord below the twist were gangrenous. Orchidectomy was done with complete and uneventful recovery—the patient leaving the hospital within a week.

BIBLIOGRAPHY

CABOT, A. T. Gangrene of testicle. Boston M. & S. J., 1903, cxlix, 428.

CHUTE, H. M. Torsion of the spermatic cord. Boston M & S. J., 1919, clxxxi, 231.

MURRAY, D. M. Torsion of spermatic cord. J. Am. M. Ass., 1920, lxxv, 377.

O'CONNOR, V. J. Torsion of spermatic cord; 2 cases and review of literature. Surg., Gynec. & Obst., 1919, xxix, 580.

RIGBY, H. M., and HOWARD, R. H. Torsion of the testis. Lancet, 1907, i, 1416.

ROBERTSON, J. I. Torsion of the cord causing gangrene of the testicle. Med. J. Australia, 1915, i, 213.

SCUDDER, C. L. Strangulation of the testis, torsion of the cord; a review with report of one recent case. Ann. Surg., 1901, xxxiv, 234.

TUFFIER. Gangrene, par torsion du cordon, d'une testicule en ectopie inguinale. Bull. et mém. Soc. de chir. de Paris, 1903, xxix, 551.

WAY, M. H. Torsion of spermatic cord and gangrene of the testis. Guy's Hosp. Gaz., 1898, xii, 212.

DYNAMIC ILEUS AND ITS CAUSATIVE FACTORS[1]

BY FRANK D. MOORE, M.D., F.A.C.S., CHICAGO

IN considering the question of dynamic ileus, we have to deal with a condition which is, perhaps, comparatively uncommon, and yet which is so little understood as to its definite causation and its means of prevention, as to prove a very serious question, when it does arise.

In reviewing the literature and in going over the work which has been done on this subject, there are two points which are immediately brought to one's notice: First, the variation in the meaning which different writers appear to ascribe to the term dynamic ileus. Some use it to mean only a spastic, non-mechanical obstruction of the bowel. Others use it to include all non-mechanical obstructions. The latter is evidently the most commonly accepted meaning of the term and it is with this meaning in mind that this discussion has been prepared, that is, any form of intestinal obstruction which is due, not to an actual blocking of the lumen of the bowel by adhesions, pressure from without, or tumors or foreign bodies within, but those forms which are due to an abnormality, either an excess or a deficiency in the contractile power of the intestinal wall.

The term paralytic, as a subdivision of dynamic, ileus is also a bit misleading, as many authors speak of all non-mechanical ileus as paralytic, the dynamic as a form of spastic paralysis and the adynamic as a flaccid paralysis. It is undoubtedly true that many more cases of ileus, particularly the postoperative ones, are paralytic than was formerly supposed. It has even been estimated that as high as 65 to 70 per cent of all cases of intestinal obstruction are, in reality, forms of paralytic ileus.

The second point which we note is the scarcity of any real research work on the direct causation of dynamic ileus. Considerable work has been done on the direct cause of death in cases of intestinal obstruction, and numbers of cases have been cited, reporting the coincidence of various affections with the sequelæ of symptoms, known as intestinal obstruction, while others report the pathology found at autopsy. It seems fairly well established, at present, that the direct cause of death in these cases is the absorption of toxins produced in the obstructed loop of bowel and formed as the end-products of disintegrated proteins. A considerable amount of experimental work done upon animals seems to substantiate this theory very materially.

It is also a recognized fact that certain operative conditions; namely, prolonged ex-

[1]Read before the Chicago Surgical Society, March 2, 1923.

posure of the intestine, eventration of the bowel, excessive manipulation at time of operation, as well as injury done to the bowel-wall through rough handling, all tend to produce an atonic condition of its musculature. Other accidents due to the operative interference may be thrombosis or embolism of the mesentery with resulting anæmia of the blood vessels supplying the part. In fact, the predisposing causes that have been considered as responsible for dynamic intestinal obstruction are numerous, almost too numerous to mention. Among them are:

Atony from excessive manipulation; atony from injury at time of operation; atony from a previously weakened condition or from a general systemic depression; mesenteric thrombosis or embolism; local peritonitis; general peritonitis; pre-operative saline purging; postoperative purging; pre-operative and postoperative starvation; excessive draining of the tissues through vomiting or prolonged withholding of fluids; eventration of the bowel, either through accident or through faulty technique at operation; overdistention by gas; bacterial infection; anæmia of the mesentery from any cause; severe and chronic constipation; reflex atony from disturbances of the nervous system in other parts of the body; postoperative uræmia; toxicity producing spasm of the bowel; increased susceptibility of the nervous system previous to operation; disturbance in nerve-control; overactive sympathetic; inactive vagi.

A previous weakened condition from long or exhausting illness and the pre-operative use of saline purges are predisposing causes, as well as postoperative overdistention by gas, local or general peritonitis, or post-operative uræmia.

Toxicity in any part of the bowel may cause a spastic condition, although this is found much more frequently in primary spastic ileus than in postoperative obstruction.

Excessive manipulation with consequent prolonged exposure of the bowel wall and probable trauma to delicate tissues, occurs in a number of reported cases as a probable causative factor. This can, of course, be eliminated by a good technique in a number of operations, but is also unavoidable in others, such as enucleation of large tumor-masses, cases complicated by necessity of resection of portions of bowel, etc.

A previous weakened systemic condition is noted also in a large number of cases, and produces a flaccid paralytic condition usually of a large portion of the bowel. In these cases, there is a decided predisposition to a weakened musculature, not only of the bowel wall, but of the whole system as well. A general systemic depression resulting either from the exhausting effects of the operation, loss of blood in shock, or to long-continued previous illness. Many surgeons lay stress on the fact that they have found in their cases of paralytic ileus, an area of infection, either a localized or a general peritonitis, in which case the paralysis of the intestine occurs as a protective effort on the part of nature to prevent the spread of infection.

Pre-operative saline purging exhausts the musculature of the bowel by overexertion before operation, leaving it in a condition very subject to later overdistention by the formation of gas, and without sufficient contractile force to overcome the resistance.

As contrasted with the various forms of flaccid paralytic ileus, we have reports of a number of cases apparently due to an increased susceptibility of the nervous system previous to operation and resulting in a spastic rather than a flaccid form of paralysis. These cases were, for the most part, in women, and in persons of very nervous temperament, who had been very much frightened at thought of operation, or worried over its possible outcome. The spasticity in these cases may be in the form of a ring only, or it may involve a considerable length of the bowel.

The toxic forms of ileus are spastic in type and are due to the absorption of toxins, either such mineral poisons as lead, vegetable poisons such as the various ptomaines, or the products of bacterial degeneration. These are rarely found as secondary or postoperative types of obstruction.

Reflex types of ileus may be due to disturbances in various portions of the body and in these cases can be attributed only to a

reflex disturbance of nerve-control. While operations on the pelvis, on the appendix, or on the kidney are particularly prone to this complication, still it has been known to follow orchitis, hydrocele, compound fracture of the bones of the leg, pregnancies, vaginal hysterectomies and operations on the breast. Atony of the bowel wall may occur from lesions elsewhere in the abdominal cavity, as well as from diaphragmatic pleurisy, etc.,—the action in this case being reflex. A general systemic depression may also produce a general atonic ileus.

While all of these conditions are mentioned and numbers of cases are cited to confirm the opinion that they are direct causes of acute dynamic ileus, the question of the actual mechanism is still in doubt. What is back of these predisposing causes? Why should any of them result sometimes in an attack of acute intestinal obstruction and sometimes not? Why should so many conditions, themselves so widely different, result in this particular bit of pathology? These questions have not been clearly answered. However, in so far as it has been worked out, the most probable etiology is that of disturbances in innervation either from the sympathetic or the central nervous system or both. This is the most widely accepted theory and most of the others really depend upon it as a fundamental working basis.

The intestinal wall derives its innervation from the vagus and the splanchnic nerves, the latter communicating with the vagus and themselves arising from the anterior cornual cells of the cord, together with their corresponding ganglia and sympathetic plexuses in the wall of the intestine itself. The vagus nerve innervates the whole of the small intestine and the effect of irritation of its fibers is to increase peristalsis. On the other hand, irritation of the filaments of the splanchnic nerve tends to inhibit movements of that portion of the intestine controlled thereby and also causes an anæmic condition of its blood vessels, while division of the splanchnic causes hyperæmia.

A paralysis of the gastro-intestinal tract, then, may result from an abnormal overactivity of the sympathetic system or from an abnormal inactivity of the vagi. This theory appears all the more probable in view of the fact that a reflex irritation of the sympathetic may be set up by such operations as that for hydrocele, with no direct stimulation of the intestinal nerves at all, the reaction being necessarily reflex.

The direct cause of death has been much studied and considerable experimental work has been done on animals with the result that death has been definitely determined to be due to the absorption into the system through the blood stream of the toxic end-products of disintegrated proteins split up within the obstructed and pathological loop of bowel. This toxicity, together with the general dehydration of the body-tissues and the depression of the nervous system, is the direct cause of death.

The various methods of treatment are all founded on the basis of combating toxicity and dehydration by transfusions and injections as first treated and, secondly, of opening and draining the obstructed loop and also of removing the toxic products to prevent their later absorption into the blood stream through another, perhaps healthy, portion of bowel.

SUMMARY

There is considerable confusion in the terminology of acute ileus, aside from the strictly mechanical forms of obstruction. The best acceptance, however, is that of dynamic ileus as including all those forms of acute intestinal obstruction which are non-mechanical and which are due to some abnormality, either excessive or deficient, in the contractile power of the intestinal musculature. This abnormality may result in either the spastic or the flaccid type of paralysis.

There are many causes given to account for the occurrence of acute dynamic ileus, including the widest possible range of pathological conditions. All of these, however, are in themselves only predisposing causes, and all must, of necessity, have back of them, some really fundamental factor as the basic etiology.

The most widely accepted and, at present, the most correct theory advanced as to the nature of this fundamental factor, is a disturbance in the innervation of the bowel

wall, whether this disturbance takes place in the plexuses in the intestinal wall, those of Meissner and Auerbach, in its sympathetic ganglia, or in the cord itself, is not essential, and undoubtedly varies with the particular causative factor in each case.

The direct cause of death is generally conceded, in dynamic ileus, as well as in mechanical obstruction, to be absorption into the body of the toxic products of disintegrated proteins formed within the obstructed loop of bowel, together with dehydration of the body tissues.

The treatment consists, first, in combating the toxicity and dehydration, and, secondly, in relieving the obstruction by drainage of the obstructed bowel and removal of its toxic contents.

BIBLIOGRAPHY

ANDREWS, A. Acute intestinal obstruction. New York M. J., 1922, June 7.

APFEL, H. Ileus due to appendicitis. New York M. J., 1922, Aug. 2.

BACON, D. K. Intestinal obstruction. Arch. Surg., 1921, Nov.

BLOODGOOD. Dynamic Ileus Following Abdominal Operations. 1897; Intestinal obstruction. Johns Hopkins Hosp. Bull., 1907.

CHAPMAN, C. Intestinal obstruction. Brit. M. J., 1922, Mar. 4.

FINNEY, J. Acute intestinal obstruction. Surg., Gynec. & Obst., 1921, xxxii.

FLINT, E. R. Acute intestinal obstruction, a series of 282 cases. Brit. M. J., 1921, May 21.

GOTTSCHALK, S. Acute ileus. Med. Klin., 1921, Aug.

HAMILTON. Intestinal Obstruction, 1919.

JACOBSEN, H. Spastic ileus. Abstracted J. Am. M. Ass., 1922, Jan. 13.

KEEN. Textbook. Keen's Surgery.

MARTIN. Postoperative Ileus. Baltimore: 1907.

MAYO, C. Cause and relief of acute ileus. J. Am. M. Ass., 1922, July 15.

MCKAY. J. Missouri M. Ass., 1920, Jan.

MCKENNA. St. Joseph's Hosp., Chicago, 1909.

MURPHY, J. B. Classification of ileus. J. Am. M. Ass. 1896.

NAGEL. Spastic ileus. Abstracted J. Am. M. Ass., 1922, Jan. 21.

OCHSNER, A. J. Practice of Surgery. Chap. by Fred Murphy.

O'CONOR, J. Acute intestinal obstruction. Brit. M. J., 1922, Sept. 30.

PLETH. Anomalies of the Mesentery as Causes of Intestinal Obstruction.

RIGGS, H. W. Intestinal obstruction. Canadian M. Ass. J., 1922, June.

SOHN, A. Spastic ileus. Deutsche Ztschr. f. Chir., abstracted J. Am. M. Ass., 1920, Sept. 11.

STAM. Intestinal Obstruction. 1921.

STONE, H. B. Toxic agents developed in course of acute intestinal obstruction and their action. Surg., Gynec. & Obst., 1921, May.

WALKER, I. J. Postoperative obstruction of small intestine. Surg. Clin. No. Am., 1922, Aug.

WATKINS, T. J. Atonic postoperative ileus. Surg. Clin., Chicago, 1920, Dec.

WEEKS and BROOKS. Intestinal obstruction following operations occurring during convalescing period. California State J. Med., 1922, Dec.

OVARIAN HÆMATOMATA

By E. MURRAY BLAIR, M.D., C.M., Vancouver, British Columbia

IT is rather an extraordinary thing that hæmorrhages of the ovary have, until recent years, received such little attention from the profession, despite the fact that the ovary, of all the organs of the body, is the most prone to hæmorrhage. It may have been generally felt that the pelvic organs in woman have a God-given right to hæmorrhage for reasons best known to themselves and the less comment the better.

The great majority of ovarian hæmatomata were considered as possibly without demonstrable pathology. In consideration of the close proximity and closer relationship with the physiologically bleeding uterus, was it not a fair assumption that most ovarian hæmorrhages were physiological?

The important elements of the ovary according to present-day teachers are:—(1) follicles, (2) corpus luteum, and (3) stroma.

Believing that there was an etiological reason for the origin of hæmatoma of the ovary, Novak (1) endeavored to explain the phenomena from a scientific basis. He showed, I think, pretty conclusively, to the great rank and file of the profession, that all hæmatomata of the ovary originate from one of the above basic factors.

It has recently been shown by Sampson (2) very conclusively that certain hæmatomata occur in the ovary which do not find origin in any of these basic ovarian factors, and for the etiology of the tumors one must look outside the ovary altogether. His masterly articles of recent dates have, as it were, brought many knotty points in the pathology of the female pelvis into a clear light. He has shown that certain ovarian hæmatomata have an endometrial origin. He believes that particles of endometrium become implanted on the surface of the ovary, that the ovary stimulates the endometrium there implanted as it does in the uterus, that a cyst is there formed and continues to grow as the embedded endometrial tissue continues to "menstruate." He seems satisfied that it is a simple regurgitation of menstrual blood accompanied by endometrial tissue along the fallopian tubes. His theory has, indeed, many convincing arguments.

For the past 25 years it has been an established histological fact that uterine epithelial tissue may be encountered in other pelvic organs than the uterus, as the tube, ovary, broad ligament, rectovaginal septum, etc. How this uterine epithelium, often true endometrium, can be found outside the uterus has been under discussion for many years. The earliest theory that I can find is quoted by Frank (3) and is that by von Recklinghausen, 1896, sustained later by Peck, again later by Ernst. They speak of adenomyoma of the genital tract generally and offer proof that the etiology is developmental from mesonephric rests. The majority of their cases were later refuted pathologically by Robert Meyer (4) and others. Cullen's (5) articles on adenomyoma of the rectovaginal septum are of much interest. He shows repeatedly the presence of uterine epithelium and even mature endometrium in the rectovaginal septum. Concerning the etiology he states: "We know nothing as to the origin of these tumors but it is certain that their glandular elements are identical with those of the mucosa of the body of the uterus."

Russel (6) reported the first case of menstruating endometrium in the ovary, and he bases his theory of origin on the statement that the embryological uterine epithelium and the ovarian germinal epithelium arise from a common source, and it is reasonable to suppose that occasionally an exchange of function could take place.

Meigs (7), in a recent study of material at the Free Hospital for Women, Brookline, corroborates the microscopic findings of Sampson. He suggests that "certain parts of the germinal epithelium of the ovary are able to undergo a metaplasia and take on the function and histology of endometrium. He

gives the histological findings which suggest this hypothesis.

The theory of Janney (8) is to my mind the most rational explanation of the phenomenon. Our own explanation of the etiology as here given, is chiefly along the same lines as his theory. Whether uterine epithelial tissue is implanted in the ovary developmentally or in mature life is still a debatable question, we agree.

THEORY OF ETIOLOGY

It is, I think, an established histological fact that the endometrium is derived through a long developmental process from the primitive funnel of the muellerian duct. The ovary is derived from an area known as the tubal area and develops chiefly from the median side of this area. Usually the mullerian duct lies laterally to this area, but by lying medially, at once the developing uterine epithelium would be in close proximity to the developing ovary, and we can readily conceive of a portion of this uterine epithelium, the endometrium to be, becoming included in the ovarian development. Why, then, do we not get cystic formation in the ovary immediately menstruation starts? Naturally the same circulating ovarian hormone will induce menstruation in endometrium wherever it may be.

1. It may be that primitive uterine epithelium in the ovary is retarded materially in its development on account of its unusual surroundings.

2. If the implantation be at or very near the surface of the ovary, hæmorrhagic cyst formation may gradually progress, but so slowly does it progress because of its foreign environment, that it usually appears as a clinical entity during the latter years of menstruation.

3. Should the implantation be deep in the substance of the ovary, the back pressure of blood menstruated, together with the general hindrance caused by the surrounding ovarian tissue, usually causes early atrophy of the endometrial tissue *unless acted upon by an outside stimulus*.

4. The same stimuli which cause follicular corpus luteum and stromal cysts to increase to pathological entities probably act on the mature endometrial implants, carrying them through to cyst formation and perforation.

STIMULATING FACTORS CAUSING HÆMORRHAGE

Believing as we do that some stimulating factor must enter in, in the great majority of cases of pathological cyst formation, whether of endometrial origin or not, we next turn to the causal factors. The causes are legion, chiefly predisposing, and are best summarized by Stein (9) as follows:

Local. (1) Menstrual (excessive menstrual hyperæmia); (2) non-menstrual (a) active hyperæmia (acute or chronic oophoritis); (b) passive hyperæmia (thrombosis, torsion, varix); (c) primary or secondary neoplasms.

General. (1) Diseases altering the composition of the blood: (a) Infections—as typhoid, acute exanthemata, etc.; (b) general disorders of nutrition (anæmia, chlorosis); (c) hæmophilia; (2) phosphorus poisoning; (3) burns; (4) venous congestion of abdominal viscera, as in heart and lung diseases.

Considering the subject from its broadest aspect, we believe that the great number of ovarian hæmatomata may cause little or no disturbance clinically and the tumors are found accidentally at operation or autopsy. Others again may cause serious menstrual and abdominal symptoms and even abdominal hæmorrhage through perforation with possible endometrial implantation on any peritoneal surface.

These facts have recently been brought home to us in a very striking manner, and the belief that possibly our experience will be of very material benefit to others has prompted us to report the following cases:

CASE 1. Patient, a female, age 31, a nurse, unmarried and very probably a virgin. She consulted Dr. Riggs regarding severe, intermittent pains in her lower abdomen, concentrated in her lower right quadrant, with tenderness just over Poupart's ligament and pubes.

Her menses had always been regular from age 14, appeared every 31 days, and of 3 day interval, accompanied by a varied amount of pain always. In October, 1921, she had sharp pains in the pelvic region which came and went intermittently, occurred at the beginning of the menstrual flow and lasted from 1 to 5 hours. She felt nauseated but did not vomit. She says she felt pains chiefly in rectum and vagina.

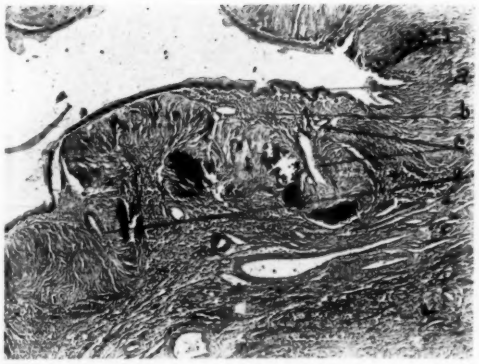


Fig. 1. Low power photomicrograph showing *a*, columnar epithelium; *b*, stromal tissue rich in blood vessels; *c*, numerous well-developed glands.

In November, 1921, she had more severe pains than usual across lower abdomen during her menstrual period.

In July, 1922, 2 days before menses, she had an acute attack of pain in her right lower quadrant and extending across pelvis was felt in rectum and vagina. Pain lasted some 6 hours.

In January, 1923, she had a sudden, sharp attack of pain in the lower abdomen, concentrating just above Poupart's ligament, right. She had two or three exacerbations of pain during the day. Moderate general rigidity. She had a feeling of being "full of gas." Acute pain lasted 1 day and she felt miserable for several days. Soreness in the abdomen persisted, and she could not straighten up properly. She was nauseated but did not vomit.

Examination 3 days after attack showed tenderness over right ovarian region and McBurney's point. Rigidity was chiefly on right side with rebound pain. By rectal examination no mass could be felt. Although not typical, a provisional diagnosis was made of acute exacerbation of chronic appendicitis with appendix located over brim of pelvis. She had a temperature of 101°; pulse, 84; blood pressure, 112–68; white blood cells, 13,600; polymorphonuclears, 74 per cent.

At operation performed by Dr. H. W. Riggs, at the Vancouver General Hospital, the abdominal viscera were found stained as though with old blood, a small blood clot was removed from the cul-de-sac, the appendix was atrophied, no signs of inflammation. In right adnexal region was found a spherical cystic tumor, some 7 centimeters in diameter, springing from the remains of the right ovary. Very little ovarian tissue remained. The cyst and ovary and tube were bound down by adhesions but were delivered quite easily. On pressure, a brown chocolate-colored substance spurted from the cyst through a small perforation, and right oophorectomy and appendectomy were performed. The right tube was apparently normal.

Fig. 2. High power photomicrograph showing part of Figure 1. *a*, Columnar epithelium; *b*, well-developed gland; *c*, cilia (well seen with oil immersion).

Macroscopic examination. Specimen consists of a simple thick-walled ovarian cyst, some 7 centimeters in diameter, through which is exuding a thick, syrupy, chocolate-colored fluid from a small perforation.

Microscopic examination. Figure 1 is a low power photomicrographic view of portion of cyst wall and cyst cavity. A regular and unbroken layer of columnar epithelium is seen lining the inner surface of the cyst. Below is a loose layer of stromal tissue rich in blood vessels. Numerous well developed, somewhat dilated glands are seen interspersed irregularly throughout.

Figure 2 is a high power view of part of the same field as above. Columnar epithelium is here well seen lining the cyst. The glandular development is quite matured. In the interior angle of the larger gland cilia are well seen with oil immersion magnification.

Figure 3 is a high power view of a near-by field; shows quantities of old and new blood in interstices of stroma.

CASE 2. Mrs. A. S., age 37, married. Very unsatisfactory history could be obtained at time of operation. Is a very garrulous patient with remarkable multiplicity of complaints referred to nearly every region of her body. Her history is considered quite unreliable and so of no value.

At operation by Dr. J. J. Mason, on opening abdomen, bilateral cystic ovarian masses bound down by dense adhesions to all surrounding tissues

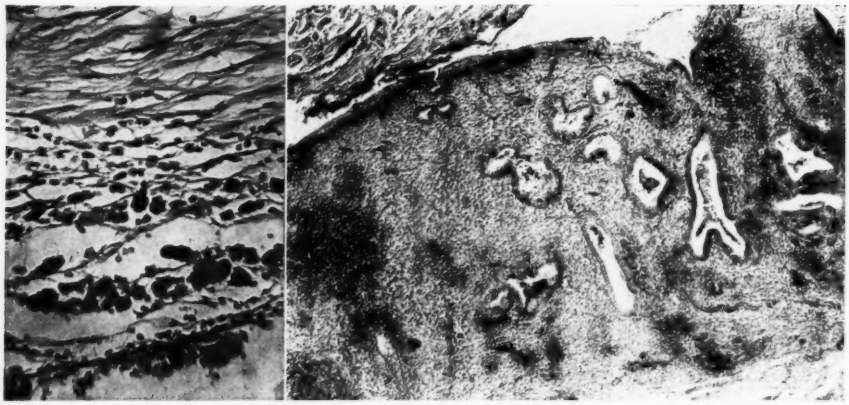


Fig. 3 (at left). (Case 1.) High power photomicrograph of loose stroma with marked deposit, old and new blood.

Fig. 4. (Case 2.) Low power photomicrograph of normal endometrium (functionating) implanted in ovarian tissue.

were found to fill the pelvis. Right ovary was practically disintegrated and densely adherent to broad ligament. On removal some ovarian tissue was undoubtedly left behind. The left ovarian mass was adherent in the cul-de-sac. Neither tube, though involved in masses, showed inflammation. Bilateral salpingectomy, bilateral oophorectomy (partial), suspension uteri and appendectomy were performed.

Macroscopic examination. Specimen consists of two tubo-ovarian masses, each a tube and part of an ovary matted together by adhesions. Originating from left ovary is a cystic mass, 7 cm. in diameter. On opening a thick, chocolate-colored syrup was liberated. Sections taken from wall of cyst and accompanying tube.

Microscopic examination. Figure 4 is a low power photomicrograph showing true endometrial tissue in every detail, and implanted on apparently normal ovarian tissue.

Figure 5 is another low power photomicrograph of the same area, still showing true endometrium.

Figure 6 is a high power field of a portion of Figure 5 to show the maturity of the gland development.

It would seem pretty well established that the two cases here described are hæmatomata of endometrial origin. Here are cystic tumors with the characteristic chocolate-filling contents, lined by columnar epithelium. One contains loose stroma, rich in blood vessels with mature gland formation in which cilia can be demonstrated with deposits of old and new blood. The other shows true endometrial tissue in a beautiful manner. We are proud that we have been able to demonstrate unquestionably the presence of gland formation in the menstruating area in both cases. Case 1 required the cutting and examining of some 30 slides before glands were found. It is, perhaps, possible to discuss a primitive or incomplete endometrial tissue under very abnormal surroundings, without the presence of glands. But endometrial tissue which menstruates is a functionating endometrium, and we find it hard to conceive of a functionating endometrium where glandular development cannot be demonstrated.

The writer has carefully examined every specimen of cystic ovary received at the Vancouver General Hospital in the last year, but has failed to find any hæmatomata that showed any possibility of endometrial origin. Two fine specimens of hæmatomata of undoubted corpus luteum origin were found. No specimens, however, were recut for the purpose of further search.

Should the regurgitating theory of Sampson be a fact, and well may it be a fact despite our belief to the contrary, one of the great lessons for the gynecologist is that practically always a retroversion precedes and aids the regurgitation process. We do not mean that every symptomless retroversion should be corrected, but in every operative procedure in

Fig. 5. Low power photomicrograph of same area as Figure 4 still showing true endometrium.

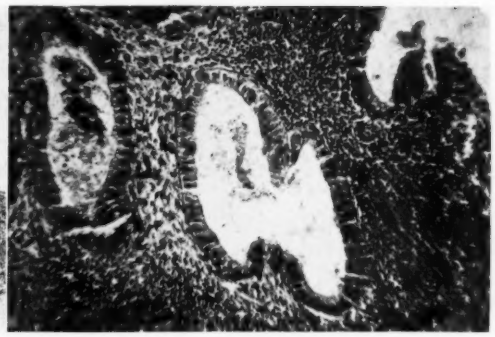


Fig. 6. High power photomicrograph from Figure 5. Note perfection of gland development.

the pelvis it should be considered. In an examination of the literature we note that the condition at times apparently followed some operative procedure. All too often do we find that after operation on tube, ovary, myoma or extra-uterine pregnancy, the uterus is left with less support than it had, a prey to the adhesions which must invariably follow to some degree. The old axiom of Murphy to "Get in quick and get out quicker" is not to be taken literally at the expense of uterine position.

CONCLUSIONS

1. Perforating and especially recurrently perforating hæmatomata of the ovary are probably all developmental uterine epithelium implantations.

2. The great majority of hæmatomata which do not perforate but may still cause menstrual symptoms and abdominal pain, are follicular, corpus luteum, or stromal in origin.

3. The same stimuli needed to carry follicular corpus luteum and stromal cysts of the ovary on to pathological entities, act, we believe, on implanted uterine epithelium to carry it on to mature endometrial tissue, cyst formation, and perforation.

4. Recurrent attacks of abdominal pain in the female pelvis, during the child-bearing period, may simulate appendicitis but be caused by a recurrently perforating hæmatoma of the ovary of endometrial origin.

5. Sampson's theory of origin of perforating ovarian hæmatomata, while still without substantiation as far as we know, is a plausible theory. In view of that fact the notice of the profession should be drawn to the added complication which may arise from a uterus in mal-position.

REFERENCES

1. Novak. Bull. Johns Hopkins Hosp., 1917, Nov.
2. Sampson. Arch. Surg., 1921, Sept.; Boston M. & S. J., clxxxvi, 14.
3. Frank. Gynæcological & Obstetrical Pathology.
4. Meyer. Veit's Handbuch der Gynaekologie, loc. cit., 2nd. ed., i, 474.
5. Cullen. J. Am. M. Ass., 1914, Mch.; 1916, Aug.; Johns Hopkins Hosp. Bull., 1917, Nov. Distribution of adenomyoma containing uterine mucosa. Arch. Surg., 1920, Sept.
6. Russell. Bull. Johns Hopkins Hosp., 1899, x.
7. Meigs. Boston M. & S. J., clxxxvii, No. 1.
8. Janney. Am. J. Obst. & Gynæc., 1922, Feb.
9. Stein. Inaugural dissertation, Halle, 1908.

DEPARTMENT OF TECHNIQUE

A FURTHER REPORT UPON THE EPITHELIZATION OF THE MAXILLARY SINUS IN CHRONICALLY DISEASED STATES[1]

By J. EASTMAN SHEEHAN, M.D., F.A.C.S., New York

THE operative experience of the 15 months which have elapsed since I had the honor of presenting my first report to the society will, I trust, prove sufficiently interesting and perhaps valuable, in view of the importance of the subject, to justify this further presentation. In addition to the account which I shall give of that experience and the extent to which it has resulted in modification of the views expressed in the earlier paper on the treatment of disease of the maxillary cavity, I shall also attempt a general epitome of antral disease.

The experience which has resulted in such conclusions as are herein set forth is not, of course, the detached or separate experience of the last 15 months, but rather of 4 years of work performed in this country and abroad of which the shorter period involves the more recent and, therefore, the more valuable part, since in it have been more thoroughly tested and determined the correctness of such of the earlier methods as have been retained in their integrity and the desirability of such of the modifications of those earlier methods as have since been adopted.

While I am entirely sensible that, in so far as what I am to relate is the result of purely personal experience, it is questionable whether it would justify the demand on your time and patience, yet since that experience has been largely gained through the generous assistance of the acknowledged authorities both here and abroad, to whom I can do no more than humbly express my grateful appreciation, it can in a proper sense be said to be more than a mere personal experience that I am recording. Moreover I have had the benefit of the disinterested and unselfish assistance of devoted associates and the advantages resulting from the reference by my professional friends and associates of interesting operative opportunities.

Finally, in expressing my obligation to others, the demonstration of the work to which your attention will be directed is made much more satisfactory and intelligible through the exceptional drawings prepared by the artist, Mr. A. Feinberg.

Fifteen months ago there was no literature to consult on this subject and, in consequence, each man who dealt with it could theorize from his own limited experience only. There was one exception to the absence of bibliography. Stratt, of Berlin, had set forth his unsuccessful attempts in 1889 to transplant full thickness skin to this cavity. Hardly a helpful treatise. During the last 15 months, however, Ferris Smith, of Grand Rapids, Michigan, who is here tonight, in a very important article, which appeared in the *Journal of the Michigan State Medical Society*, April 22, 1922, reported thirty-two instances of epithelization of this cavity. My own experience has not been so great as his, numbering only 20 operations. There is a marked similarity, however, in the reported experience and conclusions of both of us working at different posts and in complete ignorance of each other's methods.

Fig. 1. The gum incision extending from the labial frenum to the premolar tooth. Note the incision is made well above the teeth. This allows for easy approximation of the flaps when stitching.

[1] Read before the New York Academy of Medicine, February 28, 1923.

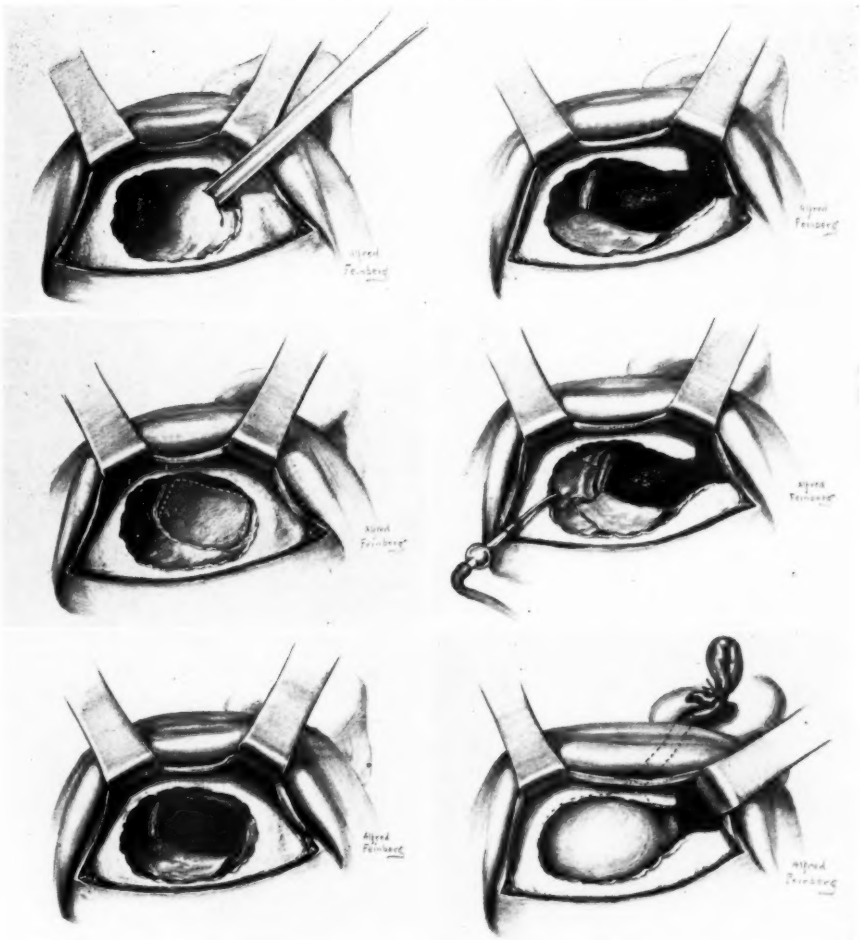


Fig. 2. The radical operation. The periosteum and mucous membrane are held out of one's way with suitable retractors. Anterior maxillary wall has been removed exposing the recess. Chisel tearing away the maxillary nasal bony wall.

Fig. 3. The anterior maxillary and nasal bony walls removed, leaving the nasal mucosa *in situ* intact. The dotted line represents the proposed incision in the nasal mucous membrane.

Fig. 4. The flap of nasal mucous membrane is turned into the antrum resting on its floor to provide a future lining. The inferior turbinate bone is trimmed throughout its entire length at a previous sitting, to destroy contact and not function.

Fig. 5. The ultraradical operation. Removal of the angle of bone formed by the junction of the anterior and nasal walls, thus making a common opening between the nose and the maxillary recess anteriorly. Many times disease exists in this angle which necessitates the removal of the entire bone in this area. Note the inturned nasal mucous membrane to the floor of the antrum to provide a lining. The inferior turbinate is freed from contact, still its function is conserved.

Fig. 6. Skin grafts in position and made adherent to the bony walls by using the Ballance suction tube.

Fig. 7. Even and firm pressure is exerted upon the grafts by inserting a rubber balloon through the nose and inflating it to the desired degree of tension; its catheter attachment is tied with silk thread.

Fig. 8. The incision is closed with horse hair and sealed with tincture of benzoin.

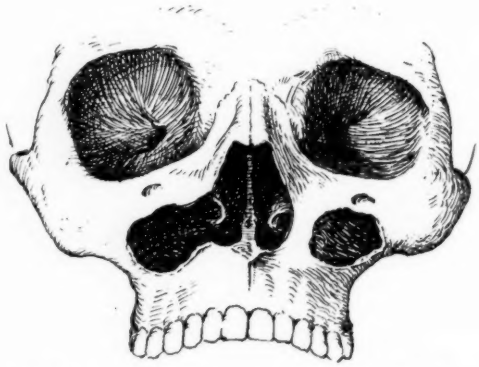


Fig. 9. The finished operations on skull. The ultra-radical operation on right, the radical operation on left.

Since writing this article my attention has only recently been drawn to a paper entitled, "Plastic Surgery, Its Interest to the Oto-Laryngologist," written and delivered by Ferris Smith before the Throat Section of the American Medical Association which convened at New Orleans, in April, 1920, in which he states that he has epithelized the maxillary sinus fourteen times. Surely priority in this work is his.

The predisposing factors, causes of infection and symptomatology, are too well known to require more than the briefest reference. Unfavorable anatomical configurations, such as abnormalities of the middle turbinate, deflections of the nasal septum, disease of the nasal vicious cycle; in short any condition which may cause partial or complete blockage of the airway constitutes a predisposing factor. Infection may be communicated to the sinus by the extension of disease from the nasal mucous membrane through the circulation or through the alveolus as in the case of the eruption of teeth or the extension of dentigerous cysts into the cavity. It may also be the consequence of traumatic causes and of such chronic diseases as tuberculosis, syphilis, malignancy, and leprosy.

Local symptoms do not always indicate the infection, and its existence is not infrequently disclosed by asthma, bronchitis, bronchiectasis, rheumatism, indigestion, either gastric or intestinal, and pain of a dull character in the lumbar region with extreme lethargy, simulating diabetes. The last condition was the only symptom in 1 of the 20 cases constituting my own experience. Local symptoms, as might be expected, may consist of a one-sided discharge either of a serous, mucoid, or purulent character with or without odor, cacosmia, neuralgia, face ache, migraine, etc. Pain over the maxillary antrum is no necessary part of chronic suppuration in this channel, since it may be suggestive of periosteitis, gumma, or new-growth, and may merely manifest an acute exacerbation of a chronic condition.

PATHOLOGY

The mucous membrane becomes hyperæmic, then hyperplastic, with œdematous changes, grayish in color, wrinkled and papillomatous, loosely held by the underlying bone, later connective with retention cyst formations.

In places the glands and vessels may become atrophied, in others dilated. The ciliated epithelium in part or in whole is changed to the pavement form with round-cell infiltration; ulceration of the bone may take place, and generally means an infection of a virulent organism with increased intrasinal pressure. Necrosis and bone atrophy may also appear in the pathological picture. Local alveolar necrosis is generally dental in origin, as from an infected or abscessed tooth.

The diagnosis depends upon the history, signs, and symptoms, and is assisted by the transilluminator introduced by Hevyng. The dental findings and roentgenogram afford more or less confirmatory evidence. The exploratory needle of Schmidt should be used, and there should be lavage of the antrum. Many times the pus is fetid and frequently flocculent. At other times a small amount or even a decided turbidity is sufficient to determine the diagnosis of empyema.

If one uses a black vulcanite vessel to receive the returned fluid, any trace of pus will be observable. The antrum should be probed after the exploratory needle is retired to determine the presence of polyps and cysts, and sometimes necrosis of the bone may be thus ascertained.

PRE-RADICAL OPERATIVE TREATMENT

It is quite difficult to determine beforehand what prospects there are of curing a chronic case by lavage through the nasal wall with instillation of drugs.

My practice is, as advocated by Dahmer, to make a very large opening in the nasal wall with an inturn mucous membrane flap to prevent closing by granulations. The inferior turbinate bone is trimmed throughout its full length to destroy contact. Function is not affected. The sinus is irrigated every second day using a 5 per cent solution of magnesium sulphate. This solution has several advantages, it being a mild antiseptic, an analgesic, and a solvent of mucus. The irrigations are carried out every second day for 5 or 6 weeks with instillations of argyrol, silvol, collene, and, if there is a decided and progressive diminution in the amount and purulence of the discharge, the treatment is continued. After the first week, the sinus is ionized every fourth or fifth day, using zinc sulphate. The results obtained at times through this form of treatment are surprisingly gratifying.

If these methods fail to effect a cure in from 6 to 12 weeks the reason is generally excessive polypoid degeneration of the mucous membrane or possibly bone involvement. Radical surgery is then advised.

THE OPERATION

Every attempt must be made to diminish shock by gentleness, conservation of heat and anæsthetic. A theatre temperature of 75° F. and hot water bags in proximity to the patient are necessary. Careful planning of the details of the operation allow it to be carried out in an unhurried manner in from 40 to 50 minutes. The preparation of the surgical field is important, as added infection may seriously interfere with the success of the graft. The parts should be scrubbed with green soap, then with alcohol, and finally with ether. As a rule local anæsthesia is my choice.

The following solution has proved very useful:

4 Novacaine	.15
Antipyrin	.032
Adrenalin chloride (1:1000)	.26
Distilled sterile water ad 30.	

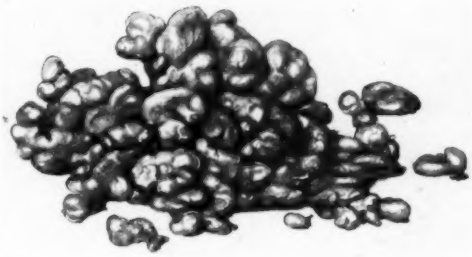


Fig. 10. Drawing by artist of an enormous amount of degenerated tissue, recently removed from the maxillary channel. The patient had several operations performed on this cavity during the past 3 years. After the ultraradical operation and epithelization of the bone, he was discharged as cured within 15 days.

A postnasal balloon instead of a plug of gauze is inserted through the nose and inflated. This is obviously better than using a gauze plug. After the parts are thoroughly anæsthetized, an incision is made at a point a little to the right or left of the frenum of the lip to the second premolar tooth, care being taken to begin well above the gums so as to allow for retraction of the mucous membrane, as difficulty will otherwise be experienced in finally stitching the surfaces together. The periosteum is now freely reflected upward, care being taken not to mutilate it, and it is held out of the way with suitable retractors. The anterior wall of the sinus is hurriedly broken through with a small chisel and the comminuted bits of bone removed. A Coffin suction tube is immediately thrust into the cavity to express blood, secretion, and débris, thus giving an immediate clear operative field. The maxillary opening is freely enlarged in all directions, care being taken not to injure the infra-orbital nerve, thereby preventing weeks of unnecessary agony. The edges of the bony opening are thoroughly trimmed and polished.

The soft parts of the nostril are freed from their attachments, exposing the pyriform aperture. The sinus is carefully inspected and, with the probe, the extent of the infection and the necessity for an ultraradical or radical operation determined. If the former is decided upon, the mucous membrane lining the nasal wall and floor of the nose is freed from its bed. The angle formed by the junction of the anterior and nasal walls is removed along with all of the maxillary nasal wall, thereby making a common opening between the nose and the sinus in front, and thus exposing the anterior superior angle of the sinus. The cavity is freed of all its diseased membrane

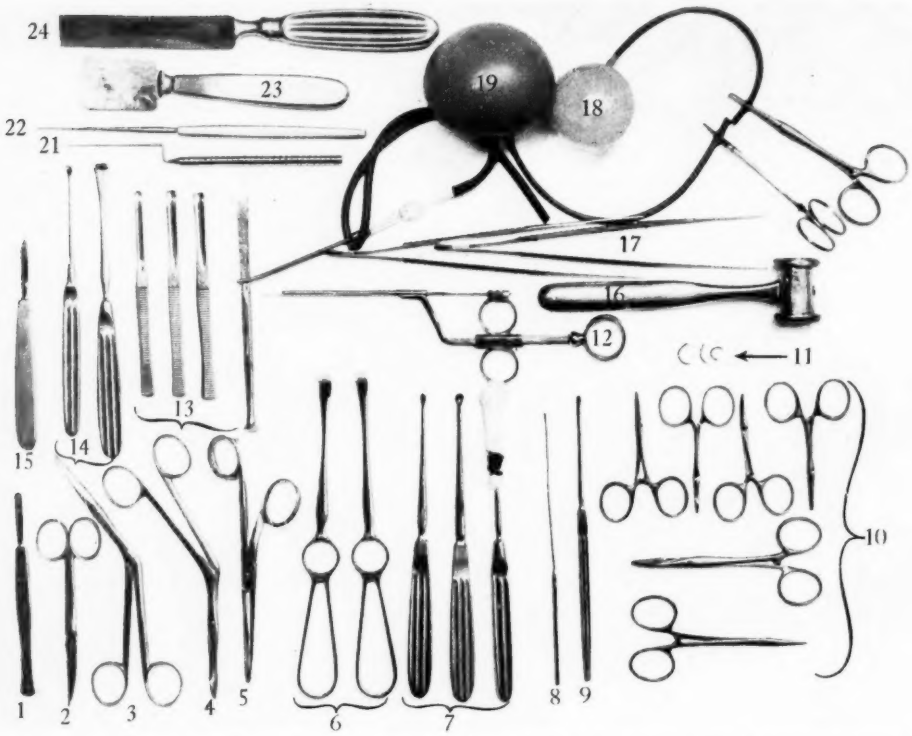


Fig. 11. *1*, *9* and *14*, Periosteal and mucous membrane separators; *2*, *3*, scissors; *4*, punch forceps for removing adherent tissue; *5*, author's modification of Gillies' suture forceps (see *New York Medical Journal*, April 19, 1922); *6*, pair of retractors; *7*, set of curettes (note one is covered with gauze, as the naked curette is never used in removing diseased tissue from the antrum); *8*, probe; *10*, special artery clamps; *11*, set of needles; *12*, nasal snare; *13*, set of chisels (see *New York Medical Journal*, April 19, 1922); *15*, scalpel; *16*, mallet; *17*, tissue forceps; *18*, antral balloon; *19*, postnasal balloon to act as a postnasal plug; *20*, Ballance suction tube; *21*, *22*, author's skin graft spreaders, *23*, skin graft spatula; *24*, author's skin graft knife.

by the use of dry gauze wrapped around a curette. The naked curette is never used because of the possibility of injuring the bone, which may be the cause of infection after the graft is placed over the newly made lesion. The cavity is packed with gauze saturated with adrenalin chloride to insure a dry field. An incision on three sides of a rectangle is made in the nasal mucous membrane, which is thus reflected to the floor of the antrum to act as a lining. If radical operation is to be adopted, the subsequent procedure is according to the method of Caldwell-Luc.

INSERTION OF THE OLLIER-THIERSCH GRAFT

The graft is cut preferably from the right inner aspect of the thigh to include the papillary layer of the corium. If properly cut only a slight amount of punctate bleeding ensues (Davis). The graft is placed upon a metal plate with its raw surface uppermost and evenly spread out. It is then covered with gauze wet in physiological salt solution, until used in the area to be grafted. Several small grafts are placed over the exposed dry bone of the antrum and made adherent with the use of the Ballance catheter. Even and firm pressure upon the engrafted area is assured by inserting a small balloon with catheter attachment through the nose and inflating it to the desired degree of tension. The external wound is closed by suturing with horse hair and sealed with tincture of benzoin. After the fourth day the balloon is deflated and removed through the nose. The sinus is irrigated with 5 per cent solution of magnesium sulphate and dried with

air irregularly until desquamation is complete. Upon inspecting the cavity there is then found a white, even, smooth surface. Elevation of temperature rarely exceeds one degree.

Formerly I used strips of gauze and later pledgets of cotton saturated in Dakin's solution to exert pressure upon the graft. I have now abandoned their use as the reaction in many cases was quite severe and the success of the graft uncertain.

GENERAL RESULTS OF OPERATION

Twenty cases in all, twelve males and eight females, constitute the experience from which these observations have been drawn. In fourteen of these the graft was an immediate success. Of the remaining six, two were subsequently regrafted successfully. These fourteen cases were discharged as cured in from 10 to 30 days. The unsuccessful cases took from 5½ weeks to 4 months to heal. One case developed a very persistent form of osteitis wh ch took quite 3 months to subside. Another had a severe infra-orbital neuralgia lasting 4 weeks in which the patient passed through a stormy and agonizing period.

The fairly large number of unsuccessful cases I attribute to faulty technique. Since that has been improved and we have adopted and perfected the use of the balloon our methods are more assured and our results better.

SUMMARY

The advantages of epithelization of the maxillary recess after the removal of disease are:

1. That the mucous membrane is replaced by skin which assumes some of the function of the membrane.
2. That the formation of scar tissue is prevented.
3. That weeks and possibly months of irrigations are rendered unnecessary.

Fig. 12. Eradication of disease of antrum after the method of Denker. Thiersch graft covering bony surfaces with pledgets of cotton to keep the graft in place. This technique is now abandoned.

4. That the cavity is not packed with gauze and after-treatment is consequently short and not painful, with little local or general reaction.
5. That the skin changes its character after a period of weeks, assuming a pinkish white color.
6. That the patient is returned to a state of health in a comparatively short period of time.

In view of the fact that we are in the realm of experimental work I firmly believe the results obtained are most gratifying and, in concluding this account of my personal experience in connection with the surgery and epithelization of this recess, I desire to record my conviction that, by fair and constructive criticism, you may advance the methods described to you tonight to a stage where complete success will be the average prognosis where they are used.

THE SHARP AND STERILE SCALPEL

By W. WAYNE BABCOCK, M.D., F.A.C.S., Philadelphia

MANY of the methods in use for the sterilization of surgical knives are objectionable, either because they dull the sharp edge of the instrument, require bactericidal measures in which the surgeon cannot have absolute confidence, or are inconvenient. Alcohol is an uncertain germicide, and the stronger non-corrosive solutions, such as phenol, trikresol, formalin-borax, may be prevented from reaching the metal by an air bubble, a film of grease, blood clot, or other material. The boiling of knives for 3 minutes while other instruments are considered to require 15 minutes, is inconsistent. The heating of knives in mineral oil until a sufficient tempera-

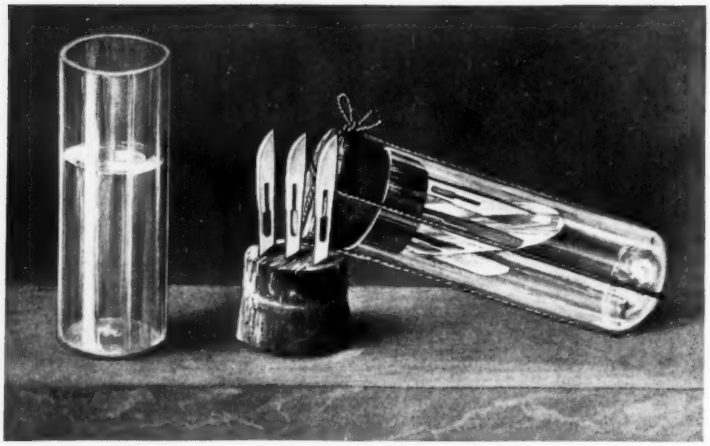


Fig. 1. Author's method of keeping knife blades sterile.

ture is reached, as shown by a thermometer or by the faint smoke given off by the oil, would seem to be more dependable, although requiring greater watchfulness.

For some years we have submerged our scalpel blades in a protective non-corrosive solution and placed them in the sterilizer to boil with the other instruments. Knife blades that have been continuously in the solution for more than 5 years remain bright and sharp, and repeated or long-continued boiling has little appreciable influence upon the cutting edge of instruments covered by the liquid. The solution is miscible with water and is readily rinsed from the instruments. It consists of—

Liquor cresolis compound, 5 parts,
Pure glycerine, 95 parts.

The simplest method of use is to stick the butt end of several Baird-Parker blades in the cork of a wide-mouthed vial nearly filled with the solution, as shown in the illustration. The cork is then firmly tied in, so it will not blow out when in boiling water, and the bottle and contents boiled as required and as long as desired with the other instruments, including the separate knife handles.

Immediately after use, if the blades are rinsed, dried, and replaced in the solution, the cutting edge will be preserved.

The portion of the knife embedded in the cork may become tarnished by the boiling water that penetrates the cork, but this does not interfere with the cutting edge.

More desirable than the glass vial is a steel cylinder or box with a rack to hold the blades, and a water-tight lid or cover. Similar receptacles containing the non-oxidizing solution may, of course, also be used for protecting and sterilizing hypodermic and sewing needles, and other delicate edged instruments.

A "THERMOSTATIC DRIP" APPARATUS

By J. BUCKSTEIN, M.D., New York

A FACTOR of undoubted value in the administration of fluid into the human system, is the conservation of the temperature of the fluid. This is particularly true when fluid is administered intravenously. The simplest and most practical method for attaining this purpose is to employ an inverted vacuum bottle. There is, unfortunately, one difficulty in the use of such a container, that is the fact that, lacking transparency, it is impossible to see just what progress the fluid is making as it leaves the bottle. At no time is it possible to determine the exact level of the fluid or the amount present. This has been a serious objection to the popularization of such a container,

which otherwise is ideal for the maintenance of a proper degree of heat.

It is obviously impossible to create a "window" in the container itself in order to make it transparent. Such an attempt would defeat the very purpose of the container by ruining its "thermos" feature. Therefore, I have employed an indirect method for achieving this result. This has been accomplished by the employment of a gauge, connected with the apparatus as indicated in the accompanying illustration. Based on the fundamental principle that fluid always seeks its own level, it can at once be seen that the level of the fluid in such a gauge will be identical with the level of the fluid within the container itself. By making the gauge of a transparent substance such as glass, it becomes possible actually to determine the exact level of the fluid within the inverted opaque container. Moreover, the value of such a gauge can be considerably enhanced by making graduations upon it, so that each division represents a definite quantity of fluid. This can be done as follows: The container is first filled to capacity and inverted. The level of the fluid in the attached transparent gauge is then marked on a metal extension. As each 10 cubic centimeters of fluid is permitted to flow from the container, a mark is made corresponding to the new level of the fluid within the gauge. In this simple manner, the gauge becomes graduated, so that each division represents 10 cubic centimeters.

Such a gauge enhances the value of the apparatus, not only by overcoming the opacity of the container and practically making it a transparent apparatus, but in addition, because of the graduations upon the gauge it is possible to determine the exact amount present within the container at any time. Also it is possible to determine the rate of flow of the fluid. Thus, if the level of the fluid is originally at the 500 cubic centimeter mark and at the end of 2 minutes, the level of the fluid registers 480 cubic centimeters, it is at once evident that the fluid is leaving the container at the rate of 10 cubic centimeters per minute. It is, therefore, evident that, by means of this simple aid, the graduated gauge, every objection to the use of the opaque vacuum bottle is eliminated. This

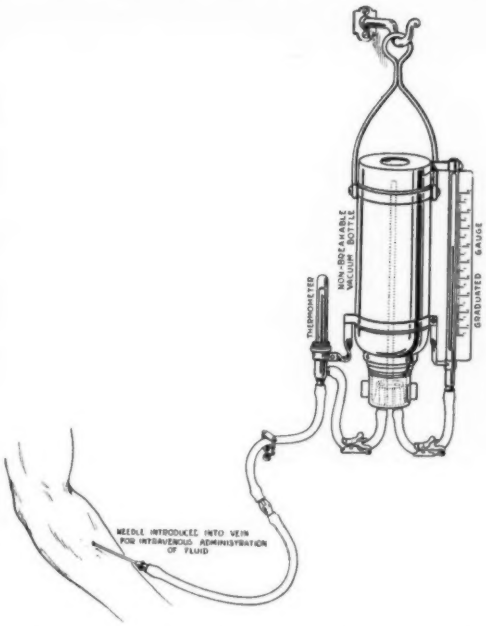


Fig. 1. Device for determining the level of fluid in vacuum bottle.

gauge is protected by metal to minimize breakage. Another advantage in using the apparatus I have devised, is that the temperature of the fluid within the container may be determined at any time. This may be done by placing a thermometer, as seen in the accompanying drawing, so that the fluid as it makes its exit from the container, bathes the bulb, with subsequent registration of the degree of heat.

ADVANTAGES

The advantages of such an apparatus, are these:

1. The maintenance of an even temperature,
2. The registration of that temperature,
3. The visualization of the exact level of the fluid at any time,
4. The determination of the rate of flow.

URETHRAL DIVERTICULA

Report of a Case of Diverticulum of the Posterior Urethra with Stone

By CHARLES P. HOWZE, M.D., Charlottesville, Virginia
University of Virginia Hospital
AND
RUSSELL A. HENNESSEY, M.D., Memphis, Tennessee
Assistant in Urology, University of Tennessee; Attending Urologist, St. Joseph's Hospital

COMPARATIVELY few cases of urethral diverticula have been reported. Ehrlich reviewed the literature in 1908 and found 68 cases to which he added one. Watts presented a study of the reported cases in 1906 and reported one. Haberer, in 1911, added two cases of Finlay and one of his own. Englander reported two cases in 1917 and Bumpus four more in 1919. Watts gave the following classification for urethral diverticula:

A. Congenital.
B. Acquired—
   1. From dilatation of the urethra due to—
      a. Calculus,
      b. Stricture;
   2. With perforation of the urethra, resulting from—
      a. Injuries to the urethra,
      b. Rupture of abscesses into the urethra,
      c. Rupture of cysts into the urethra.

He makes a further distinction between true and false diverticula, stating that the former is a dilatation of the urethra with a mucous lining identical with the part of the urethra from which it springs, and that the latter is the result of urethral rupture, and therefore has a lining of fibrous tissue.

Haberer, in his review of the cases, concluded that but twenty were of the congenital type, the remainder being of acquired type.

The case histories are incomplete and fail in many instances to give the position of the diverticula. Of the reported cases eleven were found in the posterior urethra. We have been able to find thirteen cases in which calculi were found in association with the diverticula. Ehrlich states that they are seldom multiple. Grube found two cases with multiple stones, one in which there were 162 stones and in the other 183.

The etiology of congenital diverticula has been explained by Voillemier as due to a partial lack of development of the spongy tissue of the urethra, and that it is almost identical with hypospadias formation in which there is, in addition, a defect in the skin. Kaufmann ascribes the condition to a failure of the distal and proximal ends of the urethra to unite at the time when the urine begins to flow from the bladder. The proximal end of the urethra becomes dilated, and when finally the union is made the dilatation remains as a diverticulum. Von Grigolow believes the diverticula are due to dilatations of the accessory peri-urethral ducts, which are themselves due to partial defects of the genital gutter. When these ducts enter at a very acute angle into the urethra they form valve-like obstructions which are often responsible for considerable difficulty in emptying the diverticula in postnatal life. Watts believes that some obstruction, as valve formation, congenital strictures, or phimosis, is responsible in some cases.

Referring to diverticula of the posterior urethra Bumpus states that they are probably always of the acquired type. In his report three cases followed perineal operations. He also mentions that traumatic rupture of the urethra with hæmatoma formation, production of false passages by instrumentation, and abscess formation in or about the posterior urethra with rupture into the urethra, as predisposing causes. Grunfeld and Dekeersmaecker hold that a defect in the genital gutter was responsible in their cases. Englander thinks that instrumentation accounts for one of his cases, and that the other was of congenital origin. Watts mentions stone as an etiological factor by explaining that a stone may become engaged and embedded in the wall of the urethra, and with urine pressure behind the stone on the weakened urethral

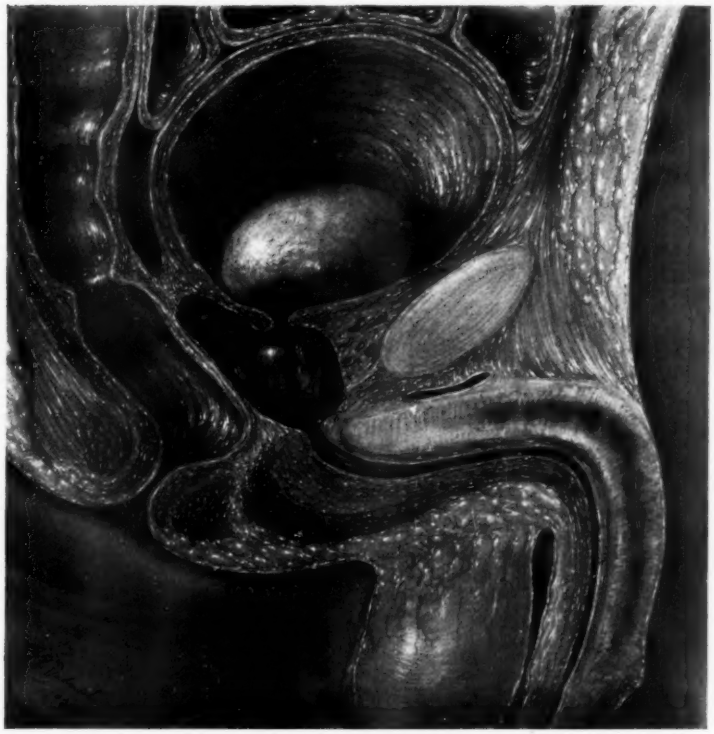


Fig. 1. Sectional view to show presence of vesical and urethral calculi and diverticulum of posterior urethra.

wall a diverticulum may form. Watts' explanation might seem to find application in our case, but because of the history of gonorrhœa, chills, fever, and acute retention, we are inclined to the belief that it followed the rupture of a prostatic abscess, and that the stone was subsequently deposited from the bladder.

Of the cases reported in which the diverticulum involved the anterior urethra a tumor was found in the majority of cases. This however, does not obtain in diverticula of the posterior urethra. In our case the stone in the posterior urethra could be demonstrated by rectal examination with a sound in the urethra. Since it was lying free in the urethra we feel that it may have exerted a ball-valve action and encouraged the distention of the pocket formed by the rupture of the prostatic abscess.

W. S., colored, single, age 31, occupation plumber, was admitted to the Memphis General Hospital August 28, 1922, because of pain over the lower

Fig. 2. Cystogram of bladder and of diverticulum of the posterior urethra.

Fig. 3. Cystogram of partially filled bladder with lead catheter coiled in diverticulum.

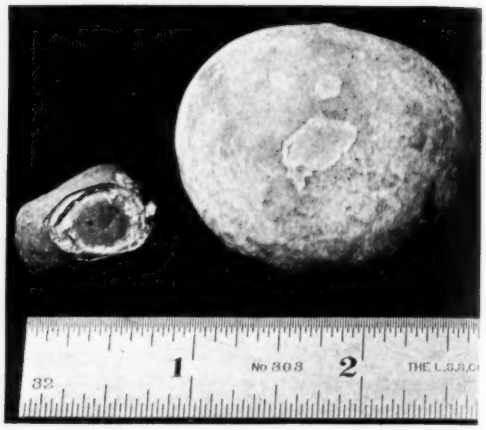


Fig. 4. Photograph of vesical calculus and smaller irregular urethral stone.

abdomen radiating into the penis and perineum, marked pain and difficulty on urination, frequency and lack of force of the urinary stream. He admits having a "strain" when a boy and states that he has had bladder distress since, but that his trouble has become worse in the last few months. At the time of his "strain" he had chills and fever and was unable to urinate until catheterized.

Physical examination showed a fairly well-nourished black male, negative except for pain on pressure over the lower abdomen and a slight urethral discharge. Penis and scrotal contents were normal. By rectum the prostate was smooth and broad; the lateral lobes were firm but elastic; the median furrow was shallow and the tissues in the midline were quite hard. No urethral constrictions were found but upon passing a sound into the posterior urethra a distinct metallic click was elicited. Rectal examination with a sound in the urethra revealed a stone in the prostatic urethra.

Cystoscopic examination revealed a large stone lying free upon the base of a trabeculated and chronically inflamed bladder. Upon withdrawing instrument a second stone was seen in posterior urethra. Vesicle neck was acutely inflamed and bleeding.

The systolic blood pressure was 125, diastolic 85. Examination of a 24 hour specimen of urine showed 900 cubic centimeters; specific gravity, 1024; reaction, alkaline; trace of albumin, no sugar, an abundance of pus, numerous red blood cells, and an occasional hyaline cast. Examination of sediment was negative for the tubercle bacillus and gonococcus but showed colon bacilli and staphylococci. Blood analysis: red blood cells, 4,800,000; leucocytes,8,600; hæmoglobin 80 per cent; Wasserman negative.

A suprapubic cystotomy was done (Howze) and a phosphatic stone weighing 45 grams, (Fig. 4), was removed from the bladder. The internal sphincter of the bladder was dilated and the stone in the prostatic urethra (Fig. 4), weighing 6.5 grams, was removed with some difficulty. Following the removal of the urethral stone, a smooth pouch could be felt extending upward from the posterior urethral wall. The bladder was closed about a rubber drainage tube which was removed on the fifth day following the operation. The convalescence was uneventful, and the patient left the hospital on the twenty-fourth day, with the wound healed.

The patient was seen 3 months later and while greatly relieved continued to complain of some dysuria, frequency, and tenesmus. A second examination was made. Cystoscopy revealed a moderate congestion particularly over the trigone and at the vesical neck. An opening was found in the floor of the posterior urethra into which a lead catheter was coiled. Bladder and diverticulum were filled with sodium iodide and X-rayed to show their relation.

CONCLUSIONS

1. Rupture of an abscess or cyst into the posterior urethra may cause a diverticulum, particularly when associated with an obstruction in the urethra.

2. An especially careful examination of the posterior urethra should be made when the appearance of the bladder does not seem to justify the patient's symptoms.

LITERATURE

BUMPUS. Surg., Gynec. & Obst., 1919, xxix, 388–392.
EHRLICH. Beitr. z. klin. Chir., 1908, lix, 193–205.
ENGLANDER. J. Am. M. Ass., 1917, lxviii, 351–354.
GRUNFELD. Harnroehre Halbmonatschr. f. Haut. u. Harnkr., 1915.
HABERER. Ztschr. f. Urol., 1911, v, 734.
ISAACS. New York J. Med., 1858, 3s., v, 9.
LANE. Tr. Path. Soc., London, 1884–1885, xxxvi, 288.
WATTS. Johns Hopkins Hosp. Rep., 1906, xiii, 49–89.

EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

FRANKLIN H. MARTIN, M.D. ..... Managing Editor
ALLEN B. KANAVEL, M.D. ..... Associate Editor

SEPTEMBER, 1923

REGIONAL ANÆSTHESIA

THE various forms of conduction anæsthesia, from the blocking of the spinal nerve roots by an intradural injection, to the obtunding of peripheral nerves by local infiltration, have fields of usefulness greatly modified by the condition of the patient and the temperament of the operator. While skillful mental diversion, narcotism, light nitrous oxide amnesia, or other expedient may overcome the fears and prejudices of the patient, any of the methods of regional anæsthesia may give the operator a sense of greater responsibility than does ether, may seriously encroach on his time, effect his mental poise, and hamper his activities. It is also true that without a wise selection of the type of anæsthetic for the particular case, the great value of local anæsthesia is largely destroyed.

It is with the bad operative risk that the gauntlet is thrown down to the user of regional anæsthesia. "Will the operation be rendered safer to the patient? Can I operate upon patients considered inoperable with inhalation anæsthesia?" "The patient might endure the operation alone, but could he withstand the anæsthetic?" These are questions which must now be answered in the affirmative. With regional anæsthesia, the surgeon may no longer delay or decline to operate because the patient is a poor anæsthetic risk. The question, "Will I operate with ease and facility" is entirely subordinate to that of the safety of the patient.

When speed and absolute relaxation are required, spinal anæsthesia, with the advantages of instant action, complete muscular relaxation, and associated peristaltic contraction, has the greatest value and also from the depression of the respiration and the great fall of blood pressure which it causes, has the largest potential danger. In the hypotension of shock, hæmorrhage, toxæmia, or asthenia, while the skillful associated use of adrenalized intravenous injections may reduce its dangers, it remains unsafe for general use. In any case, only by the intelligent application of physiological principles, with reference to the drug used, the specific gravity and percentage concentration of the solution employed, the point of injection, the amount of solution injected, the amount of cerebrospinal fluid withdrawn, and the force with which the injection is made, can uniform and satisfactory results be obtained. Modification of any of the points mentioned will influence the height and intensity of the analgesia, the degree of muscular paralysis and relaxation, the respiratory depression, and the associated fall of blood pressure. In brief, the degree of muscular relaxation, completeness of epicritic sensory loss, and the duration of the analgesia, varies directly with the dose, the concentration, and the activity

of the drug employed. For example, the action of 15 centigrams of procaine is comparable to that of 7 centigrams of tropococaine, 6 of stovaine, 3 of butyn. Three centigrams of stovaine give only about 15 minutes of analgesia, 6 centigrams of stovaine, about 90 minutes. Six centigrams of stovine in 4 per cent solution, injected in the upper lumbar region, will usually produce a fall of from 60 to 80 milligrams in the blood pressure, which passes off in 40 to 60 minutes; 6 centigrams of the stronger butyn similarly injected may cause such a complete vasomotor relaxation that the head and chest must be lowered for 3 hours after the injection to maintain a perceptible pulse at the wrist. As the vasomotor centers controlling the upper part of the body are located in the thoracic cord, the effect on the blood pressure depends upon the height as well as the intensity of action of the drug.

Selected in bad risks, the mortality of spinal anæsthesia may easily reach one in two hundred injections, and only by wise selection and very careful supervision may the mortality be reduced to one in ten or fifteen thousand. Fortunately, the later secondary symptoms from spinal anæsthesia, including headache, have been largely overcome by the use of better preparations and the avoidance of dural leakage by using only needles of small caliber.

Sacral, caudal, and paravertebral anæsthesia, while slower and somewhat less certain, and at times more difficult to induce than spinal anæsthesia, avoid the danger of the thecal puncture, usually produce little effect on the blood pressure, and give a very enduring and most valuable analgesia for operation on the pelvic organs, especially for carcinoma of the rectum. Despite the multiple punctures and skill at times required, the safety and slight effect on the general system give these methods an important place in surgery. Splanchnic anæsthesia, induced by deep paravertebral injections or more easily by retroperitoneal injections after opening the abdomen, widens the field of local infiltration anæsthesia for visceral surgery, enabling the most serious operations such as partial gastrectomy, nephrectomy, splenectomy, to be completed in patients hitherto considered too weak to withstand the operation.

Massive local infiltrations by weak, slightly toxic analgesic solutions have a large field of usefulness. The low toxicity, stimulating and enduring action of procaine, when combined with adrenalin, enable one to use such large quantities of the solution that depression, toxicity and dehydration in the patient are combated at the same time that the anæsthesia is produced. No known anæsthetic is so safe in the greatly debilitated patient and in hæmorrhage or shock, the injection may render a blood transfusion needless. The amount of the solution that may safely be employed seems almost unlimited. so that by a "shot gun" injection, effective analgesia without exact anatomical localization is available to the surgeon of average skill. The injection of from one to three thousand mils of the one-fourth per cent solution of procaine containing one to sixty thousand, to one to one hundred thousand parts of adrenalin in Ringer's solution or physiological saline is not only relatively safe, if blood vessels are avoided, but usually will materially improve the condition of the patient, and by stimulating elimination, render the free use of narcotics and sedatives safer than would otherwise be the case. An interilio-abdominal amputation skillfully conducted under local anæsthesia with nerve blocking, is a revelation to any surgeon who does not realize the great field of local anæsthesia. To facilitate intra-abdominal manipulation, an associated heavy

infiltration of the preperitoneal space about the wound is most valuable. As soon as the abdomen is opened, the finger or hand is gently introduced as a guide, the needle repeatedly carried down to, but not through, the peritoneum and 200 to 600 mils of the solution injected. By diffusion, this gives a desirable degree of splanchnic anæsthesia.

In such acute infections as pneumonia, nephritis, peritonitis with a sthenic patient, when the shortest operation with complete muscular relaxation and with the least manipulative exposure or protoplasmic disturbance is desirable, spinal anæsthesia is preeminent. In the depressed. exhausted, deeply toxic, dehydrated, starved, shocked, semicomatose or intensely anæmic patient, spinal anæsthesia is dangerous and massive infiltration anæsthesia with weak adrenalized procaine solution is invaluable. In view of the relatively slight danger from prolonged conduction or infiltration anæsthesia, it is questionable if any operation requiring over 2 hours for its completion should ever be conducted under inhalation anæsthesia alone.

W. Wayne Babcock.

TO THE "STICKS" YOUNG MAN

When a manufacturer selects a site for his plant he considers the source of raw material and the market for the finished product. To the surgeon the patient is both raw material and buyer for the finished product. If we were to follow the logic of the business man we would build our factories for the fabrication of well patients where the raw material is most abundant. The only excuse any patient can have for making long trips to medical centers is that greater talent is available there. It is illogical to collect all the best talent in great groups. Plants here and there, where they are most accessible to those who require such service, would be the solution of the business man. If a state were to be allotted ten high class surgeons by Fate, it would be conducive to efficiency to establish ten stations at opportune points. It would make for the short haul for those able to travel and it would place efficient service within reach of the injured and acutely sick. Unfortunately, there is something repellent to a young man in the thought of going to a small community. There is something belittling in it. It implies that he is not of sufficient caliber to make his way in the city. He argues to himself that he would be deprived of the stimulus of the big medical centers. That is all wrong. Each of us must find his postgraduate school in his patients and his books; the stimulus to work must come from within. The golf course does not develop the finer points of manual dexterity; the grand opera but faintly resembles the murmur of mitral stenosis; and the rudiments only of anatomy can be learned by visiting the musical comedies.

The small town has its compensations. Responsibility and freedom of thought and action are stimulants to work such as cannot be obtained anywhere else. The young man can leave his pride in the city, he will not need it in the country. All he will have there is plenty of work and will soon forget the hypothetical advantages of the so-called centers. The mere fact that the "groups" of medical talents that have in a measure brought the rural "clinics" into disrepute does not argue that such groups would not be a credit if properly manned. The chief argument in favor of this contention is that it has been achieved in many places both to the credit of the medical talent constituting them and to the advantage of the community in which they are located.

Arthur E. Hertzler.

MASTER SURGEONS OF AMERICA

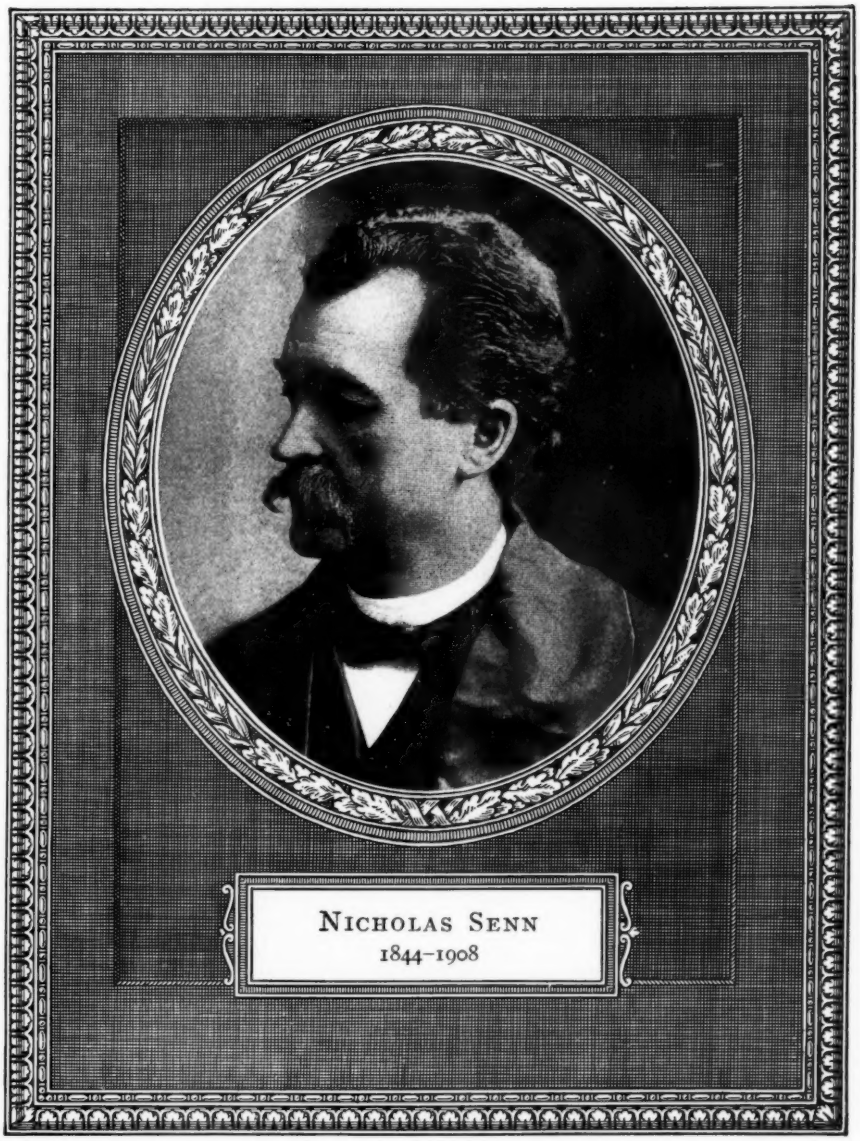
NICHOLAS SENN

IN the earlier and middle part of the nineteenth century, America was still far behind Europe in medical and surgical sciences; but the progress of modern transportation and particularly the settlement of our country with pioneers in arts and sciences have caused rapid strides of advancement, and today we excel in many respects. Without being immodest we may say that the American surgeon ranks very high among his confrères. Progress, however, always rests upon a small number of men of genius. Thus we have in the science of surgery in every epoch and every country, a certain number of renowned men who are the carriers and pillars of this advancement.

Nicholas Senn was one of those men who helped to build up the reputation of American surgery. His name is well known to almost every physician of our times.

What did he do for American surgery? How did he develop to be a pioneer and a leader? He was born in 1842 in Switzerland and came as a child to America, with his parents who settled in Wisconsin. He had all the characteristics of his ancestry, a sturdy, robust body, a clear eye, great courage, and most of all unbounded energy and ambition for work. Work represented to him the stepping stone for success. He was a genuine toiler in the field of science. His education was to a great extent that of an autodidact; at first he prepared himself for a school teacher but soon he found his way into medicine. Dr. Munk, a German doctor of the vicinity where he lived, had a great influence upon the young man: from him he imbibed the desire for study. He began to read industriously and absorbed almost voraciously medical literature; very soon he knew of the classical works of his time, and this knowledge of literature was a great help to him through the rest of his life. Particularly the experiment on animals which celebrated its triumph in those days, was a great attraction for Senn.

After graduation from Northwestern University in 1868 and an interneship in the Cook County Hospital, though he lived in primitive surroundings and had only very simple means at his disposal, he plunged into the field of scientific research and became known as the bold experimenter—on every important question of surgical technique: but feeling the necessity of more and better knowledge, like hundreds of others, he travelled abroad to study in foreign



NICHOLAS SENN
1844–1908

clinics. In Munich where he acquired the title of doctor, it was Nussbaum, and in Vienna, Billroth, who attracted him most, and he bent all of his energies to emulate them. When he returned to Milwaukee in 1874, a larger field for activity awaited him. He became a lecturer and teacher.

Microscopy and surgical pathology were new then—he was an expert in both—and he made daily observations. He became a very active and skilful surgeon whose fame spread beyond the State of Wisconsin. In 1891, the faculty of Rush Medical College called him to Chicago as a professor, and here he came in contact with a great number of students and progressive minds of the faculty. The medical men looked upon him as a great man in the field of scientific surgery and his clinic grew famous and was the attraction of his day.

Fenger, the old Danish surgeon who had an immense knowledge of pathology, was Senn's friend and adviser, and these two men with John B. Murphy, formed the celebrated triumvirate of scientific genius of the Western field of American Surgery. The merits of Senn as a surgeon were in calling particular attention to animal experimentation, to the importance of microscopic diagnosis, and to the progress in surgical technique, particularly in intestinal and bone surgery. Senn's bone plates and decalcified bone chips are well known devices of surgical technique of those days.

Dr. Senn was a tireless worker. I lived next door to him for many years, and often returning at 2 or 3 o'clock in the morning from some patient, I saw him at his desk writing on some medical subject or consulting his extensive library. I would often step into that library at that time of night and I enjoyed listening to his discussion of those very interesting phases of our science or some late advancement and discovery.

He was somewhat of a retiring character, so that only few enjoyed the privilege of being close to him. The amphitheater of his clinic was his Eldorado. One could see how he enjoyed his lecture. In stentorian voice, oratorically and with pathos, he described some pathological condition or disease, and relished the fact that students listened with rapture and admiration.

He also was fond of military surgery. This may have been brought about by his great admiration of those celebrated surgeons of his time who were at the same time great army surgeons. He often spoke on the great Ambroise Paré, of Larrey, of Pirogoff, of Langenbeck, Billroth, and Esmarch, who were his great heroes.

Dr. Senn also loved travel and enjoyed roaming about, going north to Labrador, to South America, and circling the globe by the way of Siberia or Africa, always observing and studying conditions, particularly those of hygiene and medicine. His observations and experiences he wrote down and embellished them with verse and quotations, and personally wrote in long hand many volumes. These manuscripts fill a large wall case in the present Nicholas Senn Library in Chicago, a gift for the profession by him to the Crerar Library.

He left a genuine impression on pupils to perpetuate his work.

In summing up this great man's life, who died at the age of 64 years, and the effect of his life's work upon the American Surgery of today, we must say that he was a stimulus to the younger generation to take up research work and to study pathology. His works (150 volumes), showing what a prolific writer he was, set forth a great many important observations and many great suggestions. Even if some of them did not survive him very long, the name of Nicholas Senn will stand, however, as one of the milestones and pillars in connection with the progress and high standards of American scientific medical work, particularly surgery.

CARL BECK.

BOOK REVIEWS

A CRITIQUE OF NEW BOOKS IN GYNECOLOGY AND OBSTETRICS

By GEORGE GELLHORN, M.D., F.A.C.S., St. Louis, Missouri

THAT in our days of literary overproduction a new book meets an urgent demand, is a distinction to which but few medical works may lay claim. It is in this very select class that Frank's *Gynecological and Obstetrical Pathology*[1] occupies a prominent place. The only two comprehensive works on the pathological anatomy of the female genital organs have been those by Gebhard (1899) and Frankl (1914). In the English language, however, there has existed until now no reference book on this subject which the clinician as well as the pathologist could consult. For this reason alone Frank's book will be warmly welcomed. But it is not only the first of its kind in English speaking countries, it is also a veritable encyclopædia in its completeness. An enormous number of facts widely scattered in the literature of the world has been gathered and classified. To weld this immense amount of material into the comparatively small compass of 500 pages required extensive personal experience, critical judgment, and the gift of clarity and brevity of diction; it, further, demanded restraint in including controversial matter and theoretical discussions, and it may be said at once that the author has fulfilled all these requirements in an admirable manner. The 338 illustrations are almost altogether pictures of miscroscopic sections and for the most part have been drawn by the author's own hand.

The subject matter is grouped according to the various organs of the genital tract, and there are also chapters dealing with obstetrical pathology proper, malformations, the glands of internal secretion in gynecology and obstetrics, the normal anatomy and histology of the generative system and its relation to symptoms and physiological function. In this last-named chapter the variations which occur in response to purely physiological requirements are presented lest they impress the uninitiated as pathological.

To give a few random selections from the book at large, chronic endometritis is pronounced an uncommon disease which, as a rule, is not recognizable under the microscope. In the majority of patients who complain of the conventional symptoms of "endometritis" (leucorrhæa, pain, bleeding, backache, etc.) no corresponding pathological change can be found in the uterus. "Therefore the clinician will be obliged to reclassify the complex of symptoms known as 'chronic endometritis' and distribute them among ovarian functional conditions, diseased adnexa, postpartum subinvolution, etc., where they belong." In cervical polyps secondary changes occur rather frequently which closely simulate carcinoma. In all such cases the examination of the base of the pedicle is of decisive value. It is by no means certain that gonorrhœa is the most frequent cause of salpingitis. Schridde's claim that gonorrhœa produces characteristic changes which are different from acute salpingitis due to other causes, can not be supported. The cells of chorionepithelioma have the destructive properties of the trophoblasts in the earliest months of pregnancy. The ingenious suggestion of Frankl according to which the blood serum of such patients has lost the ability of normal serum to dissolve the chorion cells, is not mentioned. For practical purposes, a thorough curettage is urged after the removal of a hydatid mole, in persistent postabortive hæmorrhages, and in the case of placental polypi. Any recurrence of bleeding should call for a second curettage and if then fetal elements are found in the scrapings, the process should be considered malignant and justify hysterectomy. Even if vaginal metastases and considerable involvement of pelvic structure have occurred, all hope need not be abandoned. Partial removal of diseased tissues has, in several cases, sufficed to cure permanently supposedly inoperable conditions.

These few selections do not do full justice to the rich contents of the book nor do they indicate the numerous original contributions of the author to our special science. This "Pathology" should be in the library of every gynecologist and pathologist.

OF the textbook of obstetrics by von Jaschke and Pankow[2] one can speak only in words of highest praise. Clearness of exposition, beauty of diction, splendid illustrations, and handsome make-up are here combined in a harmonious entity. Extensive theoretical reflections have been avoided, and where mooted questions are still under discussion, personal views and the opinions of others have been given equal prominence. That certain complications, such as contracted pelvis and placenta prævia, imperatively demand hospitalization and

[1] Gynecological and Obstetrical Pathology, including chapters on the Normal Histology and the Physiology of the Female Genital Tract. By Robert Tilden Frank, A.M., M.D., F.A.C.S. New York and London: D. Appleton and Co., 1922.

[2] Lehrbuch der Geburtshilfe. By Prof. Dr. Rud. Th. v. Jaschke and Prof. Dr. O. Pankow. 2d and 3d ed. Berlin: Julius Springer, 1923.

specialistic treatment, can no longer be debated, but the chief aim of the authors has been to emphasize those therapeutic procedures which are within the reach of the practitioner. For this reason the book recommends itself as an eminently valuable guide in general practice. A conservative, yet determined attitude on the part of the physician presupposes a clear conception of the physiological and pathological processes in pregnancy, labor, and the puerperium, and this object has been accomplished in an altogether satisfactory fashion. The extensive bibliographies at the end of each chapter furnish welcome suggestions for more detailed reading.

The study of this book has been to me a source of information as well as of keen enjoyment, and I am certain that all other readers will have the same experience.

WHAT has been said of this "Obstetrics" applies in an even greater degree to the textbook of Gynecology by the same authors.[1] But in addition there are distinguishing features which are not always found in such textbooks. On glancing over the table of contents, the reader will notice that an unusually large space is devoted to "General Gynecology" and on beginning to read—and the reading will presently prove so pleasurable that he is not likely to put the book down soon—that the authors have of gynecology a much wider conception than that of mere organ pathology or pelvic surgery. There is, for instance, a splendid chapter of fifty pages on "The sick woman" wherein constitutional anomalies (infantilism, congenital asthenia, endocrinopathies) and their rôle in gynecological diseases is discussed. In a sub-chapter the interrelations between the genital organs and the other organs of the body are pointed out. In fact, throughout the book there is a consistent tendency to show the effect of gynecological diseases and their symptoms upon the rest of the organism. Conversely, the influence of extragenital factors upon the reproductive organs and the production of gynecological symptoms without local lesions are brought to the attention of the reader.

This does not exclude a very thorough and eminently lucid consideration of the pathology and therapy of the genital organs to which no less than four hundred out of the six hundred pages are devoted. Yet, the attitude of the authors puts an effective check on a narrow and one-sided overspecialization which can see only one set of organs and forgets that these are encased within an organism.

A congenital retroflexion in an infantilistic person, for example, calls for an entirely different treatment from that of a retroflexion in an otherwise healthy woman who has acquired the displacement after childbirth. In the discussion of the causes and treatment of uterine bleeding the traditional but misleading term "chronic metritis" is definitely replaced by "metropathia" in order to emphasize that the local conditions have nothing to do with inflammation. In the question of artificial sterilization the authors practice and teach the greatest possible restraint. In gonorrhœal or septic infections of the adnexa, operation is the method of choice if the symptoms are severe enough; in tuberculous affections, on the other hand, X-ray treatment is superior to surgery. Deep X-ray therapy in general has a wide field of application in gynecology. Of particular interest are the results of radiation in affections which are characterized by intense pain or intolerable itching such as dysmenorrhœa, pruritus, and kraurosis. Non-operative methods of treatment are given greater prominence and more detailed description than is customary in gynecological textbooks.

In conclusion, the work will make many friends on this side of the ocean.

THE surgical technique as taught in the "École pratique"—we would say graduate school—of Paris is embodied in seven manuals covering the surgery of the various parts of the body. The volume[2] before me deals with the operations on the female genital tract and appears as the fifth and completely revised edition. The authors divide their book into three parts comprising, respectively, the surgery of vulva, vagina, and perineum, vaginal operations on uterus and adnexa, and abdominal operations on these organs. For each operation, only the one method is presented which has given the best service to the authors. The description is very good and considers even the most minute details, and this commendable feature is all the more necessary since the illustrations seem to me inadequate to convey a clear conception of the required steps to anyone who has not yet had extensive personal experience. On the whole, the technique recommended is very much like our own, and it is only the nomenclature that strikes us as unfamiliar. Thus, Kelly's bisection of the uterus is ascribed to Faure, the Webster-Baldy operation is named after Dartigues and Caraven, and Wertheim's technique of radical abdominal hysterectomy is credited to Lecène.

Of original French procedures Le Fort's operation for uterine prolapse deserves, according to my experience, more attention than it has found in this country. Vidal's operation for stricture of the tube was new to me; it is an adaptation of the operation for stenosis of the pylorus. In inoperable cancer of the cervix the authors recommend a method of their own.

Through an abdominal incision several catheters with small quantities of radium are introduced beneath the pelvic peritoneum and left in place for 4 or 5 days. It would be interesting to learn of the results of this rather heroic procedure.

[1] LEHRBUCH DER GYNAEKOLOGIE. By Prof. Dr. Rud. Th. v. Jaschke and Prof. Dr. O. Pankow. 3d and 4th ed. Berlin: Julius Springer, 1923.

[2] CHIRURGIE DE L'APPAREIL GÉNITAL DE LA FEMME. By R. Proust and J. Charier. 5th ed. Paris: Masson et Cie, 1922.

TO the discussion, radiotherapy versus operation in cancer of the uterus, Neuwirth[1] contributes a pamphlet of 35 pages in which he analyzes the publications of a large number of authors. His conclusions are: (1) the results of radiotherapy exceed those of Wertheim's radical abdominal hysterectomy; (2) the primary mortality of radiotherapy has been reduced to a negligible minimum while operation is burdened on an average with an immediate mortality of 20 per cent; (3) in women within the reproductive age there is a possibility of later conception as confirmed thus far by three cases in literature; surgical intervention, on the other hand, naturally results in permanent sterility; (4) radiotherapy is free from the psychical and physical shock to which a patient is exposed by operation; (5) the one or two days required for radiation treatment represent a great economical advantage over the weeks and months of convalescence from operation; (6) operation has reached the zenith of technical skill but radiotherapy has before it a wide field of possibilities, both as to its scientific aspect and its technical development.

Assuming for the moment that these conclusions are unassailable, Neuwirth's message to the practitioner might have been more impressive had the diction been more simple and direct, the construction of sentences less cumbersome and involved.

BENJAMIN FRANKLIN has said somewhere: "Wars are not paid for in war-time—the bill comes later." One is reminded of this dictum when reading Otto von Franqué's address[2] on assuming the chancellorship of the University of Bonn. The eminent gynecologist and author takes as his subject the effect of the war in Germany on mothers and their progeny. As to the latter, deleterious influences did not set in until after birth. Only 3.1 per cent of the newborn regained their initial loss of weight during their stay in the hospital. In spite of insufficient breast feeding and inadequate artificial feeding the death rate of the children during the first year of life did not go beyond the respective figures in pre-war times. Between the ages of 1 and 15 years, on the other hand, the war and even more so the subsequent blockade exacted a fearful toll, for the percentage of mortality was more than 50 per cent higher than before the war. Among the survivors, an enormous increase of rachitis was reported from all parts of Germany. The late effect of this disease in the form of contracted pelves will become manifest in from 15 to 30 years and then cause anew a great loss of lives of mothers and children. During the war and the years following, prospective mothers were placed in jeopardy first and foremost by an increase in puerperal sepsis. The death rate from childbed fever rose from 15.6 per 10,000 in 1913 to 27.7 per 10,000 confinements in 1919. In certain parts of the country the mortality rate was doubled. Lacerations and postpartum hæmorrhages likewise occurred in an increased ratio, and insufficient nutrition lowered the resistance against disease in general. Eclampsia was the only obstetrical complication which showed a decided decrease.

The statements contained in this essay merit our earnest attention. They are based on official statistics and are singularly free from any emotionalism. Rather do they breathe a deep ethical seriousness and make us wish for that Utopia which H. G. Wells paints in his *Men like Gods*, where hatred and selfishness has disappeared among human beings and life is held sacred.

WE are accustomed to regard Ignaz Semmelweis as the pioneer in the prophylaxis of puerperal sepsis and to ascribe to Oliver Wendell Holmes a theoretical insight at least into the preventability of that dread infection. In analogy w th other discoveries it might have occurred to us as it did to Horace about two thousand years ago that "brave men were living before Agamemnon," but beyond a few scattered and brief allusions to Levret, Denman, White, a.o., the literature of today dates the beginning of an effectual campaign against the ravages of childbed fever from the labors of Semmelweis in 1847.

It is, therefore, intensely interesting and illuminating to read in Adami's essay[3] that, 70 years before Semmelweis, the first successful attempt at eliminating puerperal sepsis was initiated by Charles White, of Manchester, who in a treatise published in 1773 declared that foul air and surroundings, filthy bedding, and particularly the retention of lochia and other excreta were the principal causes of the "putrid fever." He instituted a number of hygienic measures which are as obvious today as they were revolutionary in his days, and as a result of his practice he was able to say that in his extensive experience of more than 20 years he had never lost a single patient of puerperal fever while all around him deaths abounded through non-observance of the rules which he had laid down.

White himself gave no detailed statistics but among his followers, Collins of the Rotunda Hospital in Dublin could report in 1835 a mortality of 0.53 per cent in 10,785 deliveries, a result which compares favorably with the figures of the most modern institutions in the civilized world.

There can then be no doubt that Charles White deserves a prominent place in the Hall of Fame, and Adami merits our thanks for having presented to us this almost unknown phase of medical history. The full enjoyment of this brilliantly written essay is, unfortunately, marred by the polemic attitude of the author who, in order to extol his own hero,

[1] UEBER DEN ERSATZ DER OPERATION DES GEBAERMUTTERKREBSES DURCH DIE STRAHLENBEHANDLUNG. By Medizinalrat Dr. Karl Neuwirth. Vienna and Leipzig: Wilhelm Braumueller, 1923.

[2] FOLGEN DER KRIEGS- UND NACHKRIEGSZEIT FUER MUTTER UND KIND. By Professor Dr. Otto von Franqué. Bonn: Ludwig Roehrscheid, 1923.

[3] CHARLES WHITE OF MANCHESTER (1728–1813) AND THE ARREST OF PUERPERAL FEVER. By J. George Adami, C.B.E., M.D., F.R.S. London: Hodder and Stoughton, and The University Press of Liverpool, 1922.

seems to feel that he must belittle the work of Semmelweis. Yet, when all credit has been given to his inspired predecessor, the fact remains that it was Semmelweis who clearly saw and proved that the chief source of puerperal fever was septic material introduced *from without* by means of hands, instruments, and other articles, and who paved the way to modern antisepsis and asepsis.

IF Mr. McKay had entitled his book[1] "Lawson Tait and His Times" he would have prepared us in a way for the surprisingly wide outlook he gives us on surgical conditions in England and other countries in the early and mid-Victorian era. Those were the days when gynecology was just being born, when men began to break away from the tyranny of tradition and doctrine, when differences of opinion on medical subjects formed the cause of lifelong personal feuds, and the columns of medical journals were filled with long letters in which the antagonists, in polished phrases, vituperated each other. In the front line of these valiant knights stood a short broad-chested, bulky man with an enormous head and a mane of thick hair. His hands were short and broad and his fingers spatulous; yet they performed wonders of dexterity at the operating table. Such was the appearance of Lawson Tait to whose memory McKay devotes a volume of almost 600 pages. We follow his hero from his student days in Edinburgh in 1860, through a life filled to the brim with fruitful work, to his death in 1899. We see him as the hand of a loving and admiring disciple paints him, as a seeker after Truth, an indefatigable worker, a dauntless pathfinder into unexplored fields, a man of whom our own William J. Mayo said that "the cavities of the body were a sealed book until the father of modern abdominal surgery, Lawson Tait . . . carried the sense of sight into the abdominal cavity." That McKay is fair enough not to stamp his Master a saint but admits the narrow prejudices, the pugnacity, the foibles which Tait shared with other strong men, only adds to the value of the biography; and we are even made to realize that Tait always had an eye to business, as we would say nowadays.

Of particular interest to us is Tait's own account of his trip to America in 1884 in which he summed up his observations in the statement that "no Englishman can obtain a reasonably full grasp of how the world is moving, or of the numerous phases of life, medical and surgical, as well as others, until he has seen life across the Atlantic." This was not his only contact with our country. He had numerous personal friends among American surgeons, for instance Marion Sims and VanderVeer, and among the many surgeons who came from foreign countries to see his work, there were a great many from this side of the ocean. In fact, he was so overrun by Americans that he gave instruction to his footman not to admit any "Yankee doctors."

In writing Lawson Tait's biography, McKay has rendered us a distinct service. His thoroughness in dealing with his subject, his painstaking care in presenting collateral data, and a number of excellent portraits and other plates make this volume an important document which will be welcomed by all lovers of the history of abdominal surgery and gynecology.

OF making many textbooks there is indeed no end. Hence the essential requirement of any new book is that it prove its right to exist. It is doubtful whether this recent work on pediatrics[2] adequately justifies its existence. The enormous mass of pediatric material presented, plus the mass of distinguished editors, has resulted in a book lacking clarity and unity,—a compendium which has got out of hand. Editorial comments are so inextricably mingled with original text, that the attempted addition of more recent contributions results only in the confusion of the reader. This, probably more than anything else, is responsible for one's occasional sense of surprise that the work was produced as recently as the year 1922.

From the point of view of the obstetrician, the chapters on anatomic and physiologic peculiarities, mortality and morbidity, and diseases of the newborn are decidedly helpful. Being largely statistical, and less susceptible of various points of view, the confusion which mars the other chapters is much less in evidence. In the chapter on hereditary syphilis—of interest to obstetrician and pediatrician alike, the difficulty of extricating editorial comment from original text takes a ridiculous turn. On page 783 we are told to continue treatment for 14 days after symptoms of syphilis have subsided (!). On page 785 the American editor very properly sets a minimum of 1 year for infants, and 2 years for older children, regardless even of serologic effect.

I venture that the obstetricians and pediatricians who will read or who have read this book will agree that their time would have been better spent upon other obstetric or pediatric literature.

P. J. WHITE.

[1] LAWSON TAIT, HIS LIFE AND WORK: A CONTRIBUTION TO THE HISTORY OF ABDOMINAL SURGERY AND GYNECOLOGY. By W. J. Stewart McKay, M.B., M.Ch., B.Sc. New York: William Wood and Co., 1922.

[2] TEXTBOOK OF PEDIATRICS. Edited by E. Feer, translated and edited by J. P. Sedgwick, B.S., M.D., and C. A. Scherer, M.D., F.A.C.P. Philadelphia and London: J. B. Lippincott Co., 1922.

AMERICAN COLLEGE OF SURGEONS

SCIENTIFIC MEETINGS AND CONVOCATIONS IN SOUTH AMERICA

IN the course of the *Vandyck* Cruise to South America, formal medical meetings were held in three of the principal East Coast cities, namely, Rio de Janeiro, Buenos Aires, and Montevideo. At these meetings the members of the College wore the Fellowship robe, emphasizing the official significance of the gatherings. The audience in each instance was constituted of members of the local medical profession and medical students, Fellows of the American College of Surgeons, and other passengers of the *S. S. Vandyck*. Everywhere the spirit of professional brotherhood was manifested by the unlimited hospitality, courtesy, and kindness which was shown to the Fellows of the College from North America by their southern confrères.

CONVOCATION AT RIO DE JANEIRO, BRAZIL

The scientific meeting and Convocation in Rio de Janeiro was held in the brilliant Palace of Festivals on the Exposition Grounds at nine o'clock on the evening of Thursday, March 8, 1923. Dr. Miguel Couto, President of the Academy of Medicine, presided, and with him on the platform were several prominent Fellows of the College in Rio de Janeiro, the officials of the College, and the essayists of the evening.

At the conclusion of the address of welcome by the President of the Academy of Medicine, he conferred upon the Acting President and the Director-General of the American College of Surgeons the Honorary Fellowship of his Academy, and presented to each of them a handsome medal as tangible evidence of the honor.

This was followed by the formal program, which included papers on surgical subjects by Dr. José de Mendonça, of Rio de Janeiro; Dr. F. N. G. Starr, of Toronto, Ontario; Dr. Fernando Vaz, Rio de Janeiro; and Dr. John Osborn Polak, of Brooklyn, New York, the text of which appears on pages 408, 410, 412, 414, respectively.

The distinguished Dr. Olympio da Fonseca, General Secretary of the Academy of Medicine of Rio de Janeiro, was presented for Honorary Fellowship in the American College of Surgeons by the Director-General. The candidate was received by the Acting President, who, by virtue of the power vested in him by the Board of Regents of the College, conferred upon Dr. da Fonseca the honor for which he was presented.

FORMAL MEDICAL MEETING AT BUENOS AIRES, ARGENTINA

At five o'clock on the afternoon of Saturday, March 17, 1923, the Fellows of the College and other passengers of the *S. S. Vandyck* assembled in the auditorium of the Faculty of Medical Sciences in Buenos Aires for the scientific meeting and Convocation, which was conducted under the presidency of Dr. José Arce, the eminent Rector of the University. Members of the local medical profession and medical students were of the audience, and filled the hall to its capacity.

At the close of his address of welcome, the Rector called upon the Director-General of the American College of Surgeons. Dr. Martin thanked the Argentine medical profession, in behalf of the College, for the cordial reception which it had accorded to the scientific brethren from North America, after which he presented for Honorary Fellowship in the College "the distinguished Dr. Marcelino Herrera Vegas, President of the Academy of Medicine and the Surgical Society of Buenos Aires; Member of the Royal Society of London; literateur, savant, philanthropist, linguist, a citizen of international affairs, whose distinguished family laid the foundations of a great Republic." The Honorary Fellowship was conferred by the Acting President of the College, and acknowledged by Dr. Herrera Vegas as follows:

> Although I understand that the ceremonial used in your College in cases such as this is very simple and short, so much so that the honored recipient has scarcely time to answer the allocution addressed to him, I ask your permission to break with this laconism for once and beg you to concede me a few moments in which I may reply to your kind and friendly words, and also express the feelings which flood my whole being and compel me to make you my very deep acknowledgment.
>
> Personally I have a special reason for venturing to ask your indulgence in listening to me. You all know that I was called by you to different meetings of your College, in Philadelphia, in Montreal, and again in Boston, to receive the title of Honorary

Fellow of this institution, since an article of the by-laws forbids the conferring of Honorary Fellowships *in absentia*. Unfortunately I could not attend any of these meetings for private and very painful reasons that forced me to desist from making the journey, and to renounce the intimate pleasure of being admitted in your friendly and hospitable country, which I last visited nearly 30 years ago. Today, thanks to a number of happy events, most agreeable for us all, many Fellows of the College are assembled in these precincts, and the presence among them of the Acting President of the Board of Regents has made it possible for me to be formally admitted.

So I have come, as you with your friendly courtesy, which I very fully appreciate, have wished, to take part in this assembly and receive the diploma that accredits me an Honorary Fellow of the American College of Surgeons. This honor, as great as it is unexpected, is far above my poor merits; and I accept the distinction, which crowns in a very special manner my academic career, in the knowledge that it is addressed not to me individually, but through me to the University of Buenos Aires, in which I have been only a modest collaborator. The diploma you have just conferred on me is a most precious object which will occupy a place of honor, and it will never cease to bring back to me the memory of this historic assembly, formed of some of the foremost masters of American surgery of today.

I assure you this ceremony has moved me most deeply and has stirred me to the depths of my heart. It is taking place on a spot made sacred to me by the memory of many records and remembrances of my happy and gay boyhood hours, and now, with the visions passing before me of my old teachers to whom I owe so much, and my good companions, many of them fallen in the battle of life, I am living again in a flood of intimate reminiscences.

Most welcome you are, illustrious representatives of the American College of Surgeons and thereby of our great Northern sister, whose wonderful progress, especially during the last century—*still far from ceasing*—has surpassed all expectations, even the most optimistic. For me the greatest thing realized by your people, in whom have been remolded far over the seas the Latin and Saxon races, is the harmony of your development, culminating in an equal success in every path to which you have turned your steps. The vast areas of your territory, extending from the Pacific to the Atlantic oceans, and from the cold lands of Alaska to the torrid zone of Florida, crossed by great rivers and mighty mountains, are closely populated by one hundred and twenty million inhabitants, and are covered with the most populous cities of the world. Your people has created a powerful navy and a well trained army that have crossed the seas to carry the "Stars and Stripes," covered with glory, alongside the flags of the allies through the beautiful fields of France.

But above all this it has advanced artistic and scientific culture in a most admirable degree, and has spread throughout the territory of the States its hundred and fifty universities for teaching—and for more than teaching, for the development of civic virtues, ideals, and character; in a word, to quote a great American thinker, "*to form a clear mind.*"

This cruise, which has been guided by the hand of fortune, will be an outstanding milestone on the path of the scientific life of both countries. It also represents a transcendental mission of lofty educational culture, strengthening the moral bonds that link us and giving us an invaluable mental exchange, especially as regards the study of the improvement of mankind's physical and spiritual health, the work of the ever-growing science to which you have devoted your lives. And with this mingling of our minds, striving to learn one another's intellectual character better, shall we make still firmer the ties that bind together these two Republics of each extreme of this new continent—a continent whose peoples Providence has appointed to take allied action in realizing the great ideals of peace, fraternity, and love, in these sad moments in the history of mankind.

But even yet, after those great events that have shaken Europe to its foundations, in which your country gave, together with its sons, workers for the eternal ideal, the moral power of its name to the service of Justice and Liberty—even yet it does not seem that Iris will shine out in the sky and disperse those banks of black cloud, heaped up by Bellona; still we look in vain for the wise Minerva, bringing in her hand her symbol of the green olive branch. Faced by this uncertain future, when people even fear for civilization itself, all eyes are turned to these fruitful lands of America, whence will arise a new race and a new civilization, bringing an era of lofty ideals that shall raise humanity to heights of perfection never before reached.

Only one sad note sounds in our ears in this harmony of happiness and pleasure, and that is the remembrance that your stay among us will be all too brief; how it brings home to us Goethe's wish, that we could but delay the happy hours and keep you longer at our side.

I thank you, Doctor MacDougall, and all you my very good friends, for your courtesy and your goodwill, which with the merited prestige of your names add such splendor to this meeting—a meeting that will remain an ineffaceable memory in the annals of this house. You will, I hope, have formed new ties of friendship in this country, which I am sure will add a new charm to your life, bringing you a remembrance that neither time nor distance can weaken or efface.

One request I have to make of you, and then I have finished. It is that when you arrive again in your country you will give my warmest and most affectionate greetings to Doctor William Mayo, one of the pillars of modern North American surgery. To him, and to Doctor Martin, whose presence among us today it is our good fortune to enjoy, do we owe the inspiration of these happy scientific cruises

which have done, and will do, so much good service to the cause of closer and warmer relations between our two great democracies.

To you all I say in the old language of Green Erin, "Cead míle fáilté." (*Cad mili falta.*)

An abstract of the lecture by Dr. Hugh H. Young, of Baltimore, and a translation of the paper read in Spanish by Dr. James T. Case, of Battle Creek, Michigan, are given on pages 415, 417.

MEDICAL MEETING IN MONTEVIDEO, URUGUAY

In Montevideo, a formal medical meeting was held in the assembly hall of the Faculty of Medicine at nine o'clock on the evening of Friday, March 23, 1923. Dr. Alfredo Navarro, president of the Society of Surgery of Montevideo, presided.

Dr. Navarro delivered an address of welcome in Spanish, which was translated into English by Dr. Nin y Silva, of Montevideo. Scientific papers were presented by four of the Fellows of the American College of Surgeons from North America. A translation of the paper read in Spanish by Dr. Case, appears on pages 419–420. Dr. A. J. Crowell, of Charlotte, North Carolina, spoke on "Removal of Ureteral Stone by Cystoscopic Manipulation; Disintegration of Cystin Stone by Pelvic Lavage and Internal Medication," the text of which may be found on page 112 of the July, 1923, issue of SURGERY, GYNECOLOGY AND OBSTETRICS.

An abstract is given below of the talk by Dr. R. D. Kennedy, of Globe, Arizona, on "Tendon Transplantation in the Forearm Following Irreparable Injury to the Musculospiral Nerve"; also on "Sarcoma of the Upper Jaw," by Dr. John F. Barnhill, of Indianapolis, Indiana.

DR. RODERICK D. KENNEDY, of Globe, Arizona: Where the injury is above the branches to the extensors of the wrist, the pronator radii teres is transplanted into the tendons of the extensors of the wrist. After these have been drawn up sufficiently to hold the wrist in dorsiflexion, the flexor carpi radialis is transplanted into the three extensors of the thumb in as straight a line as possible from its origin to its new insertion. This transplant is done after the extensors of the thumb have been drawn up sufficiently to hold the thumb in extension. The flexor carpi radialis is transplanted into the extensors of the fingers in as straight a line as possible from its origin to its new insertion after the fingers have been extended, and the extensors drawn up sufficiently to hold them in extension. The skin incision is made so that it will not superimpose over the point of transplant of the tendons. The hand is put up with the wrist, fingers, and thumb extended on a cock-up splint and maintained in that position for about 3 weeks before any active movement is tried.

DR. JOHN F. BARNHILL, of Indianapolis, Indiana: Sarcoma is common, especially in the young. Since the disease may begin in the maxillary sinus, the posterior wall, or nasal wall, and therefore be concealed until far advanced, a late diagnosis has been made in the past. On this account operative statistics are woefully inaccurate. Early diagnosis is absolutely essential to cure. Textbooks even yet picture the appearance of the jaw as wholly indicative of the final stages, and writers continue to detail the later symptoms essential to recognition of the disease, and therefore diagnosis is too long delayed.

The rhinologist should examine these cases at a time when they are first suspected of disease. By skill and the use of all known plans of investigation, he should be able to detect the presence of the disease in its incipiency. Operation at such a time is hopeful. Deformities are obviated because at this early stage of sarcoma the disease may be widely removed and yet leave supporting portions of the jaw. Better statistics depend wholly upon early diagnosis, and better diagnosis must depend upon earlier and more skilful cavity examination.

ACTUAL CONDITIONS AND INDICATIONS FOR LOCAL ANÆSTHESIA

By JOSÉ DE MENDONÇA, M.D., F.A.C.S. (Hon.), Rio de Janeiro, Brazil

As a member of the American College of Surgeons, the great association and instrument of scientific intercourse and friendship among American peoples, I bid you welcome; and as a Brazilian physician, I thank you for your kind visit and hope that you may have a very happy trip through South America.

In spite of the marvelous progress which has been made in the science of medicine and surgery during recent years, anæsthesia remains an oppressive influence to operators and patients. Although anæsthesia was welcomed as a gift from heaven after centuries of pain, it was followed almost at once by cases of immediate death of young and apparently healthy persons, caused by the use of ether or chloroform.

The surgeon has become more confident in the use of anæsthetics because of the improvement of the technical procedure, the multiplicity of anæsthetics, the research into their toxic effect, the invention of new and complicated apparatuses, the specialization of those who administer narcotics, and the practice of a previous laboratory examination to determine the efficiency of the emunctories and the use of correctives against the toxic effect of the various general anæsthetics discovered up to this time. But we are far from being able to guarantee life to those who subject themselves to narcosis in order to undergo an operation which very often is insignificant.

This pertains to the tragic death during or immediately following the operation. Those who have spent many years in the practice of surgery know that the greater number of victims is not among these, but, rather, that the majority slowly and fatally succumb from intoxication on the second to the fifth day because the anæsthetic has a fatal influence on some organ essential to life.

Because anuria is a very apparent symptom, it was declared at first that the degeneration of the kidneys was the cause of the disaster; later the incontrollable vomiting seemed to result from liver insufficiency; and, finally, the low blood pressure and the disturbance of the heart brought into evidence certain stimulating, depressing, or coordinating organs by means of internal secretion. Be that as it may, in spite of so much practical and theoretical progress, the fact still remains, unshaken in its tragic significance, that in many cases the organism is so sensitive to general anæsthetics as to become intoxicated by them.

Local anæsthesia appeared as a ray of hope. A drug was discovered which was capable of temporarily interrupting the function of the nervous tissue, abolishing one after the other, as the doses were increased, the senses of pain, of temperature, and of touch, even, to a great extent, the motility. I refer to the marvelous effect of cocaine.

It was in 1884 that Koller explained before the Congress of Heidelberg the surgical importance of this drug, and from that time up to the present, the European and American surgeons, some of whom are present at this assembly, have never ceased in their efforts to render local anæsthesia the saving resource of those who, in the last stage of organic debility, find it necessary to undergo an operation.

Thanks to these efforts, we have at hand a method more inoffensive than any other known, capable of anæsthetizing all parts of the body without alarming disturbance to the great and essential functions of life—a method which spares the mind and vigilance of some senses but leaves the patient in a state of consciousness. The technique of this method is at present much more simple than that of general anæsthesia, and allows the surgeon to give his whole attention to his special work. It precludes thought of accidents arising from the anæsthetic, suppresses the inhibitory reflexes, permits immediate nourishment, and leaves the patient perfectly calm as soon as the operation has been completed. It is a method which contributes to the welfare of the patient and eases the conscience of the surgeon; but it is harmful to our social influence as it suppresses the emotional scenes of surgical liturgy and so takes away our prestige as terrible angels who torture for the benefit of creatures and of creation.

Regarding the technique, we have at hand nearly all of the requirements which are necessary in order to generalize the method. We have an anæsthetic which, when used in a dose not strong enough to produce for one and a half to two hours any toxic accident, allows us to render large parts of the body insensible and to operate on a clear field, even in regions largely vascular, such as the extremities, the mouth, the anus, etc. I refer to novocaine dissolved in physiological serum and combined with adrenalin.

Numerous processes of anæsthesia, used individually or in combination with others, facilitate the application of the method to the most complicated surgical cases.

A simple embrocation produces superficial anæsthesia, which permits of an examination of the patient and slight interventions, principally as they pertain to the minor specialities; but it renders to major surgery the important service of suppressing uncomfortable or even fatal reflexes, as, for instance, gulping during the removal of the upper jaw, and spasms of the larynx and the inhibitory reflexes of breathing during the dilatation of the anal sphincter.

Nearly all surgical operations may be performed without pain and with the least possible loss of blood through the process of infiltration by means of a syringe and needles of various lengths, whether this is done directly to the tissues of the part to be operated upon or whether the region is enclosed by infiltrating around it.

Infiltration anæsthetization of the nerve trunks and plexuses through the skin, enables the surgeon to pursue a certain number of surgical interventions, but without the benefits of hæmostasis.

Spinal anæsthesia with its variations—lumbar, thoracic, and cervical—is likely to produce partial or total analgesia and permits of unlimited surgical intervention; but it has no influence on hæmostasis, according to some surgeons even seeming to favor blood losses. Esmarch's bandage is seldom, if ever, used as an aid in injecting the anæsthetic into the veins or arteries.

Let us now consider the value of these proceedings as they pertain to the field of action, efficacy, facility of execution, and possible accidents.

Embrocation is at present limited, efficacious, easy to perform, and free from accidents when utilized in a strictly technical way.

The favorite anæsthetic is cocaine, combined with adrenalin.

Anæsthesia of the nerve trunks is little used and serves rather as an aid in the process of infiltration; it requires not only a perfect knowledge of anatomy, but ability as well, and extensive practice. It is certainly efficacious when an operation is to be performed in the center of a part supplied by the nerve. On the periphery, however, the variety in the distribution of the nerve fibers renders analgesia uncertain. Traumatic neuritis, which may last one or more months. may result.

Five to twenty cubic centimeters of a 1 per cent solution of novocaine-serum-adrenalin is sufficient to produce this condition.

The effect of spinal anæsthesia may be extended to the entire body, and it is efficacious in almost all cases. The technique is simple and within the reach of any operator. However, it must be admitted that very serious and inconvenient accidents sometimes occur. Among the immediate ones we may mention distress, vomiting, vasomotor disturbance, and syncope, with a momentary or definite cessation of breathing and pulse; later accidents are headache which cannot be relieved even by the lumbar puncture, various degrees of paralysis, and temporary disturbances of certain reflexes indispensable to the normal functioning of some emunctories.

Finally we reach the process by infiltration which, thanks to the latest progress in technique and the possibility of anæsthetizing the splanchnic nerves, may be applied to any part of the body with true efficacy and is extremely easy of execution, for it only requires a general knowledge of the direction in which the nerves run and the manner in which the anæsthetic will spread. That is, the spaces bounded by the skin, the aponeurosis, the bones, and serous membranes. Surely the process is safe which uses solutions so diluted (½ to ¼ per cent) of a drug six times less toxic than cocaine and combined with adrenalin which localizes its effect and strengthens the heart.

Immediately following the use of larger doses, some of the patients manifest chills, with stronger heart-beats, but with undisturbed breathing.

This lasts only a few moments. As a later accident I have only observed, during the 13 years I have used the method, a momentary elevation of temperature (37.5 to 38) within the first 48 hours, and paræsthesia which lasts from 1 to 3 months.

It is easy to understand why infiltration is gradually taking the place of spinal anæsthesia and narcosis when it is considered that in addition to the aforementioned qualities this process has the added advantage of keeping the field of operation bloodless, of avoiding previous hæmostasis and loss of time in drying the wound, of precluding accidents caused by the flow of blood in the trachea, and of preventing collapse due to hæmorrhages which frequently occur in certain operations performed under general anæsthesia, such as removal of the upper jaw and of nasopharyngeal polypus.

If it were only necessary to abolish pain to enable one to operate in complete tranquillity, all operations, whether major or minor, could be performed under local anæsthesia; but the calmness of the patient is an important factor in the performance and the results of the operation.

The operator must influence the patient through suggestion, win his confidence, and turn his attention in every way from the operation. This constitutes local anæsthesia an inferior practice as compared with narcosis, and another intermediary method—anoci-association—so well studied by Crile. While it may be inferior in some cases, it is never contra-indicated, except in agitated, insane, or extremely timid people, nervous children not easily pleased or tempted, and in patients who are to undergo certain laparotomies where the extent of the injuries cannot be calculated.

It is beyond understanding why an attempt is being made (under pretext that the injections may cause metastasis) to remove cases of septicæmia and pyæmia from the jurisdiction of local anæsthesia, particularly when it is possible to inject healthy tissues or the nerve trunks that serve the part to be operated on. These patients, if subjected to any other anæsthesia, must undergo surgical manœuvre, which is more apt to lead to the consequences which are feared.

The same is true of the scars and œdematous regions which, due to resistance to the spreading of the anæsthetic, would render anæsthesia ineffective were it not possible to surround the part by injecting the neighboring tissues.

Setting aside the contra-indications above mentioned, it may be affirmed that, after the later progress obtained, local anæsthesia should be the

method of choice, giving place to anoci-association and to narcosis when peculiar conditions belonging to the clinic case render local anæsthesia inconvenient.

The simplicity and sureness of local anæsthesia allowed Kulenkampf to use it in 24.6 per cent, Laewen in 49.92 and Hartel in 60.05 per cent of the cases on the battlefields during the World War. When doctors shall have become familiar with this sovereign resource, which appears to the author to be the most important victory since the advent of antiseptics, this percentage will continue to rise until it covers nearly the whole field of our surgical activity.

RESULTS IN GALL-BLADDER SURGERY

By F. N. G. STARR, C.B.E., M.B., M.D., C.M., F.A.C.S., Toronto, Ontario

IN studying gall-bladder disease, it is necessary to make clear that "gall-bladder disease" does not necessarily mean "gall stones," because the formation of stones is merely an incident associated with gall-bladder infection, plus inflammation. There are so many phases of inflammation of the gall bladder that it is necessary to approach the treatment from two standpoints: first, as a life-saving measure; and, second, from its economic aspect.

I. LIFE-SAVING MEASURE

Acute inflammation without jaundice. The patient may or may not recover spontaneously, with but little trace of the disease, though later in life gastric symptoms may develop from adhesions and a gradual fibrosis of the duct.

Acute inflammation with cystic duct obstruction without jaundice may result in a large cystic gall bladder which, sooner or later, will require surgical intervention.

Acute inflammation with rupture of the gall bladder is a rare condition as in our experience it occurred but three times in 450 cases. In this series we have also had four cases in which anastomosis occurred between the gall bladder and duodenum with a resulting intestinal obstruction in one and in another an obstruction at the duodeno-jejunal junction produced by a mammoth stone that could not get through the opening in the transverse mesocolon.

Acute inflammation with so much associated thickening of the duct as to produce obstruction with jaundice.

Acute inflammation with common duct obstruction from stone, giving rise to jaundice.

If a suitable time is chosen, these cases largely reduce themselves into acute imperative conditions demanding surgical intervention, and in such the question always arises: Should drainage be instituted or should the more radical procedure be followed? The method of choice must depend largely upon the condition of the individual patient. Each case demands the most careful surgical judgment.

After all, the first essential is to relieve pain, and the second to save life. A brilliant operation, followed by a funeral a few days later, reflects no credit upon surgery. It is infinitely better to save a life with the possibility of a further restorative operation in the future.

II. THE ECONOMIC ASPECT

Distressing symptoms should be relieved, such as pain under the right costal border, or in the epigastrium associated with the tenderness over the lower dorsal roots. Oftentimes the patient volunteers the information that he fears to take a long breath because of the discomfort it causes him He often complains of the distaste for food or nausea at the sight of food, due no doubt to an associated pyloric spasm. Others do not wish to partake of food because of the consequences, the distress coming on within an hour after eating. In a large percentage of the cases, distress depends upon the kind rather than the quantity of food taken, it being caused by fats, fried food, and certain vegetables. The large majority complain of gas on the stomach, and many (32.4 per cent) suffer from constipation. Of these, 72 per cent were entirely relieved by the removal of the gall bladder. Diarrhœa is present in very few cases, but when it does occur discomfort in the upper abdomen precedes the attack. In one of our studies, 29 per cent suffered from mucus in the stools. In these cases we found a staphylococcus aureus in the gall bladder and of them 65.2 per cent have been entirely relieved of the so-called "mucous colitis."

In this type of case we must endeavor to increase our efficiency, and we must further seek to prevent later complications such as—

1. The acute conditions formerly mentioned;
2. Chronic pancreatitis;
3. Hæmorrhagic pancreatitis;
4. Carcinoma resulting from the continued irritation.

METHOD OF PROCEDURE

Having arrived at the decision that the patient is suffering from gall-bladder pathology, the question naturally arises: How shall we proceed? A few

cases will develop an economic efficiency under a strict diet régime, associated with a mild laxative and an anti-spasmodic. If operation is decided upon, there must be careful preparation. Any preliminary purgative must be given several days before the operation. The patient should then be given all of the nourishment he can assimilate as well as all of the fluid he can take. Oftentimes it is well to give him a glucose and soda solution, either by the Murphy drip or intravenously, as the case may require. In some semi-starved, anæmic patients, a preliminary blood transfusion will assist in carrying them safely through the ordeal of a serious surgical procedure. If there is jaundice, 5 cubic centimeters of a 10 per cent solution of calcium chloride, given intravenously each day for 3 days prior to operation as suggested by Walters of the Mayo Clinic, will overcome the danger of hæmorrhage.

As an anæsthetic, the open ether method is to be preferred as it is all-important to secure perfect relaxation which makes possible the gentle handling of the viscera. After a trial of practically all of the incisions recommended, the author has settled down to a right rectus, near mid-line, incision, beginning close to the right of the ensiform cartilage, thus affording sufficient room to work comfortably and at the same time to produce a wound that will lend itself readily to healing and to the production of a sound abdominal wall.

Lest in the preliminary examination some latent pathological process may have been overlooked, it is the practice to explore the stomach, duodenum, and pancreas, as well as the ileo-cæcal region, for sometimes it is essential to deal with some further gastro intestinal pathology in order to secure the best result in the patient.

In dealing with the gall-bladder pathology itself, the first procedure is to explore the ducts carefully, and if there is a stone in the common duct, or if there is a thickening of the duct associated with a moderate amount of pancreatitis, the common duct is opened and the stone, if present, removed. Then a No. 6 gum and elastic catheter is passed through the ampulla for some distance into the duodenum. This will tire out the spasm of the sphincter, and, if need be, will serve as a means by which nourishment can be carried into the duodenum during convalescence.

The cystic duct and artery are then isolated as far away from the common duct as possible, and clamped in a double clamp. They are then cut across. A suture on a fine needle is passed between the duct and the artery and securely tied beyond the end of the forceps. The suture is then continued two or three times around the clamping forceps, and the transfixion of the duct made certain. The forceps is slipped out and the suture tightened and tied. The needle on this suture is then passed through the fold of peritoneum which can be brought up, and as the gall bladder is dissected out of its bed, the peritoneal fold can be caught on each side until the gall-bladder fissure is completely closed with a smooth peritoneal coat. If, however, the gall bladder is deeply buried in the liver and a rough surface has resulted, a free omental graft is cut and laid in the fissure, where it is secured by means of the free ends of the suture behind as well as in front, thus obviating the formation of subsequent adhesions.

If it has been necessary to put a catheter into the duodenum, the other end is brought out of the abdominal wound and may serve as a drain. If the wound is otherwise clean and dry, drainage is seldom introduced except in the presence of active infection.

The abdominal wound is then carefully closed and the posterior rectus sheath secured, whereupon the toilet of the operation is completed. When the patient is taken to his bed, he is put on a Gatch frame with his shoulders elevated, and a Murphy drip of glucose and soda solution is immediately started. In the first 6 ounces of this solution, we put from 1 to 2 drams of concentrated tincture of digitalis, since if this is done the patients do not suffer afterward with tachycardia, nor are they subject to postoperative distention or to chest complications. As soon as the patient is sufficiently awake and complains of pain, he is given morphine in an amount that will make him comfortable and produce sleep.

In order to secure the best postoperative results, it is essential to have these patients report from time to time for at least a year, so that slight defects may be remedied and that they may obtain the best possible result.

To recapitulate:

1. If gall bladder surgery is instituted soon after the first symptoms develop, the mortality is negligible;
2. The disaster of complications is avoided;
3. The efficiency of the individual as an economic asset is improved, as about 66 per cent of these patients are cured, and 34 per cent are relieved of most of their symptoms.

WHAT THE AMERICAN COLLEGE OF SURGEONS HAS DONE FOR THE SURGEONS OF RIO DE JANEIRO

By FERNANDO VAZ, M.D., F.A.C.S., Rio de Janeiro, Brazil

AMONG the hospitable countries, Brazil proudly occupies one of the first places, and, in most cases, those who visit it do not feel ill at ease in spite of its enormous territory and the difficulty of its almost unknown tongue. Among its inhabitants, mutual trust is proverbial. Those who have had the privilege of visiting the inland, and have had occasion to have personal dealings with our farmers, know that no one knocks at his door, asking for food, lodging, or information, who is not received with open arms and treated with entire disinterestedness. The Brazilian, as a general rule, gives what he has without expecting any return. This natural trait of those who live in the interior is transmitted, without any change, to its centers of greater culture, where, in spite of material progress, selfishness, which dominates a great part of humanity, does not always find lodgment.

If you will take the trouble to look into our history, you will have occasion to verify the truth of this statement. You will see, for instance, that those who govern us have a tendency to side with the weak and the oppressed. They refuse many times the possibility of great compensation, so as to be on the side of justice and right.

What is the cause of such a tendency?

It is because Brazil has always lived surrounded by people whose chief object in life has been cordiality. From its beginnings as a nation it has tried to be a defender of peace and in favor of great ideals, maintaining among its inhabitants mutual confidence, which is indispensable to mutual understanding, as also to the progress of the country.

It is this sentiment that we Brazilian physicians zealously cultivate, perhaps more so than any other class of workers. This is the reason why the majority of Brazilian physicians place above their own personal interest the health of their fellow beings, and maintain the profession at the highest possible standard of professional honor.

Our physicians and surgeons count it a great pleasure to be able to prove to those who as yet do not know them this quality of character in their profession, which, to speak candidly, is only a reflex of a general trait in our race.

In expressing this fact to you, my dear colleagues, you who understand the nobility of such an ideal, our hearts overflow with legitimate pride in finding ourselves in your company, you, whose greatness of soul has such a close affinity to ours.

Whatever be the prism through which one looks at your actions, altruism is always your dominant characteristic; and those who know you well, know that in your country those who suffer do not fear adversity, because your millionaires do not forget to divide of their abundance with those less fortunate.

None among us but has heard of the lavishness of Rockefeller, or of the work of Peter Bent or Robert Bent. If we tried to mention other cases, it would be very difficult to choose who should have the preference. As proofs of your altruism, it is only necessary to call attention to your universities, your colleges, and your hospitals (both in the homeland as well as abroad, and of which we, in Brazil, have such visible proof in the great Baptist institutions, so nobly fostered among us).

This is the reason why we feel at home with you. We bid you welcome, gentlemen, to this land of proverbial hospitality.

Every time good friends come to see us, or other countries send to our shores some special envoys who represent the glories of their country, we feel under obligation, and if unable to return in any other way, we try at least to express our sincerity in words. You may be sure that if your presence in this hall is a great pleasure to all Brazilians, it is a yet greater pleasure to the one who is at this moment addressing you.

Never can I forget your country, the kindness of your people, and your simple life, both of teachers and pupils. I never would have attempted to speak to you in your own language, were it not for the great friendship that I feel toward you. In your country, instead of the oligarchies full of disdain that unhappily still exist in some scientific centers, there prevails a powerful democracy, where all may be sure of finding a place according to their personal merits, be their origin or position what it may.

Your presence here is certainly a great satisfaction to me. I cannot but speak again of the personal interest manifested by William Mayo, one of the most prominent men of your country, who, after a visit to our part of the world and hearing of our presence at his clinic, received us with his characteristic courtesy, and inquired particularly into the real conditions of our life, about our schools, our men, and our science. Upon leaving his home I was sure of having done a great service to my country, offering to that eminent spirit the seed that is now bringing forth fruit.

Since then I have followed closely your program. Your efforts in remodeling the hospital service demand the united forces of each and every one in the marvelous work which you are planning to do.

There is no need for us to speak of the powerful influence that the surgery of your country has had upon us. In this country, as well as in other countries, your names are highly esteemed. There is no Brazilian surgeon who has not heard of the work

of Howard Kelly, whose value as a scientist is recognized in all of our books, and whose technical knowledge cleared the ground in matters of gynecology. The writings of Charles and William Mayo on gastro-intestinal surgery; of Young on surgery of the prostate gland; of Cushing on surgery of the hypophysis and of the auditory nerve, are true milestones that will make their names honored through future generations.

I now wish to present to you the little that I have been privileged to do.

In our private practice, I try to introduce all the improvements that are at our disposal. Although we do not have the riches of some of your clinics, as we depend entirely on our personal resources, yet we have the means necessary for good surgery.

We are as yet not able to show you a model hospital, active in all of its various departments; but I wish to show you one that is just now beginning, and for which I have been doing my utmost, planning to introduce there all the good things that I saw with you. I refer to the Surgical Department of the Hospital of San Francisco de Penitencia, which will be built in one of our best suburbs, in the mountains of Tijuca. The land has a frontage of 240 meters, and is a plateau extending along the mountains. The building will occupy the first elevation, and will measure 90.90 by 73 meters.

In the left wing a complete section will be given over to baths, rooms for massage, for mecano-therapy, for X-rays, and so on; in the right wing will be the store-room for surgical materials, the office, pharmacy, and the quarters for internal service; in the center will be stationed the stretchers.

The first floor will be reserved for septic surgery, and will have in each wing three wards, each containing ten beds, one ward for specially dangerous cases, and at each end recreation rooms.

On the second floor there will be an extensive circular gallery that will communicate with a special gallery enclosed with glass, reserved for aseptic operations and accessories. There will be found baths, a room for preparing the sick for anæsthesia, sterilizing room for the physician, surgical arsenal, and room for all the necessary articles and accessories for sterilization for the whole hospital, and also the office for the head nurse of the surgical department; at the side, small wards for the cases recently operated upon, private rooms, dining rooms, etc., etc.

The third floor will be reserved for laboratories, museums, library, and refrigerating apparatus for cooling the operating rooms.

Besides this, in the hospital of San Francisco de Assiz, where it is our privilege to direct the general surgical service for women, a great number of improvements have been introduced, due to the opportune initiative of the illustrious director of the Public Health Department, Dr. Carlos Chagas. In that institution, where each surgeon is permitted absolute autonomy in the exercise of his clinic, a school for nurses has recently been established under the direction of American nurses. Miss Kienegen, one of your country women, the head nurse, is doing her utmost, so that before long we may have a goodly number of graduate nurses. Then, also, a perfect and systematic examination of all anatomo-pathological material of the hospital is made in the laboratories of the Institute of Manguinhos, where, as you know, we have a group of capable anatomo-pathologists.

In this movement we are not the only ones, for, before long, you will hear of other similar undertakings, promoted by colleagues who are residing in this metropolis as well as in other parts of Brazil.

If to all of this we should add that both our federal and municipal governments are thinking seriously about the hospital problem of this city, for which your example has been such a powerful incentive, you will have a more succinct idea of what constitutes our program.

As you will readily see, the program of the American College of Surgeons, of which you are such worthy representatives, has been one of the subjects of our daily thought. With the objective in view of elevating still more the surgical profession, you try to introduce uniformity into your service. Uniting under the same flag what you have of the best in your profession, promoting in your clinics the autonomy necessary to a conscientious surgeon, you offer, to those who trust their lives into your hands, all of the advantages of a timely and efficient surgical intervention.

Working in the midst of a complete organization for the study of the sick, you awaken in the professors the desire for greater progress, and in the students, love for and dedication to the profession they have adopted. Placing yourselves in condition to practice applied surgery, on the basis of pathology, hygiene and physiology, you offer to those who desire your services real lessons in those things in life, the influence of which tells upon the medical profession in general.

It is not necessary to emphasize the sublimity of your ideal, nor the finesse of your generosity in extending, even beyond your frontiers, the benefits of your efforts. Calling into your guild the whole family of American surgeons, and trying to organize them into one strong and powerful body, the objective of which is to work on behalf of suffering humanity, you give once more an example worthy of imitation. Your initiative eliminates from American surgery the excessive centralization that has been so prejudicial to every good movement in medicine. Your College, with its great prestige, will enable all to combine in one strong, intelligent, and willing effort. You can, therefore, rest assured that you will find here our heartiest support in the task which you have undertaken.

I would like to say a great deal more, but the time allotted to me will not permit.

CONSERVATISM IN ACUTE PELVIC INFECTIONS

By JOHN OSBORN POLAK, M.Sc., M.D., F.A.C.S., Brooklyn

A BETTER understanding of the physiological pathology in pelvic lesions, and the more minute study of the habits of bacteria and of the tissue reactions excited by the entrance of the several forms of pathogenic bacteria, have done much to swing the pendulum toward conservatism in acute pelvic infections.

In arriving at a prognosis and in determining the treatment in acute pelvic infection, it is just as necessary to know the avenues of entrance, the type of bacteria, and the tissues involved as it is to know the time and place of starting when one is about to undertake a railway journey, for bacteria commonly keep to the beaten track. They reach the pelvic tissues through a point of entrance, an abrasion, or wound by way of the lymphatics, through the placental site, or along the mucous membrane of the cervix, uterus, and tubes.

The common types of bacteria in puerperal infections are the streptococcus, the staphylococcus, occasionally the pneumococcus, and the gas bacillus of Welch. In non-puerperal infections, the gonococcus alone, or the streptococcus alone or in combination with the gonococcus, are the exciters of tissue reaction.

The whole process of normal labor is so arranged that it is combative of infection. The natural division of the utero-vaginal tract at the internal os into an infected zone below and a sterile one above is well known. The mucous plug occludes the cervix until labor begins. The membranes, when intact, protect the amniotic cavity from upward migration of bacteria. The outflow of liquor amnii with its downwash of fluid temporarily cleanses the passage. The rotary scrubbing of the cervix and vagina by the oncoming child further displaces the migrating bacteria. The inversion of the placenta through the rent in the membranes protects the placental site, and finally the bacteriocidal character of the lochia in the first few hours after delivery form some of the safeguards with which nature protects the woman and which are seldom thought of by the accoucheur. Hence, unless bacteria are carried into the sterile zone and inoculate a wound, nature is competent to offer the necessary resistance.

How then does infection occur?

1. By the introduction of bacteria through traumatisms of the cervix;

2. Through inoculation of the great uterine wound itself;

3. Through the placental site when the contraction and retraction of the uterus are defective.

When inoculation occurs, the bacteria always excite some degree of reaction in the tissues invaded. Wounds of the cervix are the most common points of entrance in all hurried labors or in prolonged dry labor, with or without instrumental interference, and it is in the surrounding connective tissue (the parametrium) that the reaction is found. How effective this reaction is, depends upon the virulence of the infection and the individual reaction of the tissues. Virulent infections give the patient no chance to establish her immunity.

When the bacterium passes through a wound in the cervix into the parametrium, an exudate is poured out into the connective tissues surrounding the cervix; while if the great endometrial wound is inoculated, a protective wall of leucocytes is formed, and small, round tissue cells are poured into the basal membrane as a defense against the invading cocci. On the other hand, if the infection succeeds in reaching the peritoneum, a plastic exudate seals off the pelvic cavity by adhesions of the bladder, sigmoid and omentum. Thus does nature attempt to isolate the pelvic cavity, limit the infected area, and render the invader harmless.

How may these natural pathological processes be aided by surgery?

A clinical study of numberless puerperal lesions shows that surgery can be of little assistance; but the effectiveness of these protective processes may be furthered by certain conservative measures and so contribute to the resistance of the individual—

1. By the proper conduct of labor;

2. By the avoidance of trauma;

3. By observance of the strictest asepsis;

4. By avoiding vaginal examination and following the progress of labor by abdominal palpation and rectal touch;

5. By conservation of blood loss;

6. By securing proper contraction and retraction of the uterus;

7. By postural drainage, which contributes to this contraction and retraction;

8. By supportive treatment, the normal functions of the body being continued by maintaining the cardiac action and the blood pressure. This may be done by stimulation, the exhibition of fluids, and by small, repeated blood transfusions.

Only when the infection is still within the uterus, in the endometrium, can any surgical measure be of value; and when anything is done, care must be exercised not to disturb the physiological pathology that is going on. An effort should be made to secure the following objectives:

1. Perfect retraction and contraction of the uterus;

2. Perfect uterine drainage;

3. Sterilization of the uterine cavity.

In puerperal endometritis, with a profuse, fetid lochia, an open cervix, uterine pain, and a relaxed, soft, tender uterus, these ends may be attained by

the use of the Ill tube and iodoform gauze drains with alcohol instillations. When, however, the infection enters the blood stream, whether it does this by lymphatic extension or by the direct introduction of the bacteria into the blood stream, it becomes a fight between the bacteria and the leucocytes. If the bacteria win, they multiply and produce a bacteriæmia; on the other hand if the leucocyte kills the bacteria. the patient makes a slow recovery.

To summarize, it may be dogmatically stated that in acute puerperal infections surgery should be confined to incision and drainage of cul-de-sac or parametrial abscesses or drainage in spreading peritonitis. None of the radical procedures such as curettage, hysterectomy, or ligation of the pelvic veins are justified in the light of our present pathological knowledge.

In acute infections of gonorrhœal origin, it may be broadly stated that active surgery has no place in their treatment. For the gonococcus is a selective organism, attacks the mucous membrane, and travels by continuity either on the mucous surface or by the lymphatics in the basal membrane.

Certain foci such as Skene's urethral tubules, the racemose glands of the cervix, and the fallopian tubes become the final resting places for the Neisser bacillus, where it remains latent for indefinite periods or dies as in the tubes when the ostia becomes sealed. If the tube becomes sealed at its fimbriated end, the gonococcus dies in from 6 weeks to 3 months, provided rest and conservative methods prevail.

The ovary in pure gonorrhœal infection is seldom involved, though it may be buried in protective adhesions; hence we have come to feel that if we are to conserve the menstrual and ovarian functions in an infected woman, our best course is summed up in four words:

1. Rest;
2. Cleanliness;
3. Postural drainage;
4. Time.

You will ask: How long shall we wait before operating?

1. Until all exudate is absorbed;
2. Until the temperature has been normal night and morning for 10 days or 2 weeks;
3. Until the white blood cell count is below 11,000

and, finally, until pelvic examination or menstruation fails to excite an exacerbation. Then destruction of Skene's ducts with the fine point of the electric cautery, excision of the infected glandular portion of the cervix, and simple salpingectomy will rid the woman of every focus of infection and yet retain for her menstrual and ovarian functions.

In conclusion, clinical experience has taught us that in operating for pathological results of infection, each case should be reviewed as to the history of the infection and the location of the remaining lesion, for only in this way is it possible to decide what were the causative bacteria, which will aid us in determining the course which should be followed.

THE IMPORTANCE OF THE PERINEAL ROUTE IN DISEASES OF THE PROSTATE AND SEMINAL VESICLES

By HUGH H. YOUNG, M.D., F.A.C.S., Baltimore

THE perineal route is important as an approach to the prostate, not merely in hypertrophy, but also in carcinoma, tuberculosis, calculus, chronic infections of the vesicles as well as the prostate, and various operations for incontinence, recto-urethral fistulæ, impermeable urethral structure, and rupture of the deep urethra.

Success in the various operative procedures which are required to combat these conditions depends, first of all, upon a clear conception of the anatomy and physiology of the region; and, second, sufficient operative experience to recognize the successive fascial and muscular structures. Much of the criticism of the operation of perineal prostatectomy, and the bad results obtained, are due to ignorance.

If hypertrophy of the prostate were the only surgical problem to be dealt with in this region, surgeons might be content to do only suprapubic prostatectomies and remain in blissful ignorance of the finer anatomical and technical features of the perineal route; but, as stated above, there are many other important prostatic diseases which demand surgical relief, and which can only be reached satisfactorily through the perineum. The conscientious surgeon who essays to give proper surgical care to all such cases cannot longer ignore the perineal approach to the prostate, or fail to perfect himself so that he may carry out skilfully the operations needed for the cure of these various important diseases.

The first complaint against perineal prostatectomy, incontinence of urine, can be avoided by opening the prostatic space back of the triangular ligament and external sphincter. The anatomical details were described in a recent paper by the writer in Surgery, Gynecology and Obstetrics for April, 1923 (1), and it will suffice to say here that it is only necessary, after a curved incision in front of the anus, to open up, by blunt dissection, the space on each side of the central tendon behind the transversus perinei muscles, thus pushing backward the two levator ani muscles. The central tendon is then divided close to the bulb, and beneath it the recto-

urethralis muscle is sectioned tranversely close to its anterior attachment to the membranous urethra, after which the rectum, thus freed, can be easily retracted backward.

The next important item of technique is to recognize the posterior layer of Denonvilliers' fascia, where it covers the apex of the prostate, on each side of the median line, and, by dividing it, expose the pearly white posterior surface of the prostate. Then following upward, by blunt dissection between these two layers of fascia (in fetal life peritoneum), the entire posterior and lateral surfaces of the prostate, seminal vesicles, and base of bladder are exposed, ready for any of the radical surgical procedures necessary to attack diseases of this region.

This conservative approach has not only done away with the fearful sequelæ of the old blind median perineal section, but has opened up a vast new field to surgery.

Briefly, the salient technical features of the operation for perineal prostatectomy, and the advantages of the method, are: the avoidance of blind surgery, all stages of the operation being visible; the resultant greater conservation-preservation of ejaculatory ducts and internal sphincter; the thorough control of hæmorrhage; the better drainage, dependent and short; the simpler, quicker convalescence; the lessened danger of infection and abdominal complications. This was exemplified by the report of 1049 cases with a mortality of 3.4 per cent, in the last 198 cases of which there was not a death. In this series of 198 consecutive cases there were 58 patients over 70, and 6 over 80 years of age, showing the safety of this perineal operation.

Because of the frequency of cancer of the prostate (20 to 25 per cent of enlarged prostates), I would urge the importance of early diagnosis and radical operation. This procedure can be carried out with ease and thoroughness, thus removing in one block the entire prostate with its capsule and urethra, the neck of the bladder, the seminal vesicles with the overlying two-thirds of the trigone, and the ampullæ of the vasa deferentia. The remaining defect is easily repaired by anastomosing the wide-open bladder with the stump of the membranous urethra, and by the recent modification of technique, which preserves the nerves, blood vessels, and fascia in front of the prostate, avoids incontinence of urine, and secures perfect bladder (2).

The prostate is a well-encapsulated organ, and it is not surprising that among the 20 patients on whom this operation has been performed, the apparent permanent cure is well over 50 per cent.

In more advanced cases the perineal route also offers an opportunity of inserting radium points—either emanation in glass or 1 milligram of the salt in platinum—into the depths of the prostate seminal vesicles, base of bladder, and adjacent tissues. When there is little or no obstruction present, the urethra is not opened; in other cases the obstructions, generally concomitant hypertrophied lobes, are enucleated. The results obtained by surgery and radium in many cases have been remarkably satisfactory functionally, and sometimes curative.

The third subject is tuberculosis of the prostate and seminal vesicles, which recent studies (4) have shown to be involved in nearly all cases of seminal or genital tuberculosis. The ultimately high death rate in cases where epididymectomy or castration had been carried out, shows the importance of removing the seminal visicles and lateral lobes of the prostate. By means of the long urethral tractor and the employment of the same technique, except that the urethra is not opened, the bladder can be so depressed that a splendid exposure is obtained, and the seminal vesicles, along with the lateral lobes of the prostrate, may be removed in one piece with the deeper portions of the vasa deferentia, the remainder of which are removed through the groins with the tuberculous epididymis or testicle. By this procedure, the entire seminal tract, with the exception of the terminal portion of the ejaculatory ducts, is radically removed, and the results obtained, even in 5 cases in which a tuberculous kidney, also present, required removal, have amply justified the procedure.

The recent work of MacFarlane Walker, demonstrating that genital tuberculosis is almost always secondary to infection in the seminal vesicles and prostate, fortifies the arguments advanced for radical surgery in these serious cases.

Chronic infections of the seminal vesicles, which so often lead to grave septicæmia endocarditis and arthritis, require perineal operations, incision and drainage, or very frequently excision as completely as tuberculosis. Seemingly miraculous recoveries are sometimes obtained by such procedures (5).

Time does not permit discussion of the various other important perineal operations which are required to attack the diseases, malformations or traumatisms which cause great distress. They simply add to the *raison d'être* of perineal surgery, and the obligation which hangs heavily upon all who would conscientiously undertake the care of these cases, to master the anatomy, physiology, and surgery of the perineum.

REFERENCES

1. Prostatectomy—pre-operative, operative, and post-operative treatment. Surg., Gynec. & Obst., 1923, xxxvi, 589–609.
2. Carcinoma of the prostate: an improved technic for radical excision with preservation of urinary control. J. Am. M. Ass., 1917, lxix, 1591–1597.
3. Technique of radium treament of cancer of the prostate and seminal vesicles. Radium, 1922, i, No. 1.
4. The radical cure of tuberculosis of the seminal tract. Arch. Surg., 1922, iv, 334–419.
5. The rôle of the prostate and seminal vesicles in general toxemias. J. Am. M. Ass., 1913, lxi, 822–825.

THE VALUE OF BEDSIDE X-RAY STUDIES IN THE IMMEDIATE POSTOPERATIVE MANAGEMENT OF SURGICAL CASES

By JAMES T. CASE, M.D., F.A.C.S., Battle Creek, Michigan
Battle Creek Sanitarium

We cannot refrain from expressing our great appreciation of the honor we have in addressing so distinguished an audience of American surgeons—an audience which is truly all-American. The American College of Surgeons is an all-American institution, including in its Fellowship surgeons from practically all of the Republics on the American Continents, and the Dominion of Canada. As Pan-Americans, we are proud to be here, and gratefully to acknowledge the wonderful hospitality which has been extended to us.

As a surgeon-radiologist, I wish particularly to pay special tribute to such brilliant Argentines as Lanari for his work on the differential diagnosis of hydatid cyst and sarcoma of the lung; Heuser for his book on radiology; and Carelli for his notable contribution on perirenal emphysema.

This afternoon I wish to discuss the very great value of the roentgen rays in the postoperative management of patients after abdominal operations. Time does not permit more than mere mention of the therapeutic value of radiation in the postoperative treatment of malignant and tuberculous disease, and in the management of hyperthyroidism, either as an aid to surgery or in some cases replacing surgical operation. Neither have I time to discuss the value of fluoroscopic control in the accurate application of radium in œsophageal carcinoma after gastrostomy, or in many cases before resorting to gastrostomy; in carcinoma of the rectum or rectosigmoid, especially when the performance of inguinal colostomy permits the introduction through the disease-bearing area of a string with which to draw the radium into place under screen control. Roentgenograms are useful in controlling the accurate placement of radium-bearing needles as a prophylactic, or in the treatment of primary or recurrent uterine carcinoma with extension into the broad ligaments, and in certain cases of prostatic carcinoma.

Following operations upon the stomach or duodenum, not infrequently symptoms occur which give rise to some degree of anxiety lest an obstruction should have supervened. Such an accident, following gastro-enterostomy or cholecystoduodenostomy, may be early recognized by radiological study at the bedside following the administration of a very small amount of opaque salt (not over 10 to 15 grams) in plain water—a procedure which in our hands has never produced untoward results. Such a temporary obstruction of a spasmodic nature usually responds promptly to the use of the duodenal sound, and it is here, in the accurate placing of the duodenal sound, that fluoroscopy again renders important assistance.

For any patient who cannot be moved from the bed, bedside studies may now be easily performed with a portable apparatus which is universally available. The portable roentgen apparatus is simply wheeled to the patient's bed, a roentgen plate-holder placed underneath the patient, or at his back or chest, as he lies in the appropriate position, and the exposure of 3 to 10 seconds is made while he holds his breath.

It is especially interesting to make postoperative studies following gastro-enterostomy. Not always does the new opening function in a satisfactory manner, although the patient may recover sufficiently to leave the hospital. Careful screen study, particularly on such a useful fluoroscopic table as has been devised by Carelli, will quickly determine in which position the stomach empties most readily: whether erect, prone, supine, or lying upon the right or the left side, or in some combination of these positions; and the patient may then be instructed to assume this optimum position for a given length of time after each meal until the stomach learns to accommodate itself to the new conditions.

After operations on the intestine, with anastomosis, as after resection of a portion of the bowel, the roentgen study offers adequate explanation of many untoward results. Especially is this true when, after an ileosigmoidostomy, intestinal contents back up into the blind end of the colon. This retrograde movement of intestinal contents into blind ends of intestinal loops is so marked that we now always make an end-to-end union or a lateral union with the minimum amount of blind pouch. And few surgeons realize to what an astonishing degree dilatation of the ileum occurs after ileosigmoidostomy or any similar operation which does away with the ileocæcal valve.

A better knowledge of the course of the fistulous tract is obtained by study with the X-rays of the sinus which has been injected with some opaque mixture, whereupon the cure of intestinal fistulæ is often much accelerated.

The position of drainage tubes, or other opaque drainage material, may be easily and quickly verified by roentgen observation, especially when the operation concerns the diaphragm or some part above it. Often the entire train of unfavorable symptoms may be immediately changed, and impending defeat converted into success, by slight readjustment of drainage tubing under roentgen control. In subphrenic abscess, for example, not only may the diagnosis be confirmed at a much earlier date than by any other means, but the best method of approach-

ing the infection is easily determined with roentgen study. The patient need not be made to sit erect; it is entirely sufficient to study him lying in the supine and the left or right lateral position, as the indications may demand, without moving him from his bed. Here, especially, slight re-adjustment of drainage tubing under screen control, after the operation for drainage, has frequently re-established the flow of purulent material when the tube has become temporarily blocked in some manner.

Most important of all, however, is the employment of the roentgen rays in the early diagnosis of postoperative ileus. In *chronic* obstructions no one hesitates to introduce the requisite amount of opaque meal into the alimentary tract to permit the deliberate study of the passage of the opaque material; but in a *suspected acute* obstruction, one naturally hesitates to introduce more food into the alimentary tract. Nevertheless, early diagnosis is of paramount importance in acute obstruction, in order to minimize the profound general depression and high mortality attending late operation for ileus. It is not necessary to enumerate the various symptoms suggestive of ileus which in a fair percentage of abdominal cases become a cause of disquietude. In the great majority of instances these symptoms pass; but in a number there undoubtedly occurs a relative ileus which rights itself, often without being recognized.

In 1910 I began the employment of the bedside examination in cases of suspected ileus, including all cases of postoperative abdominal distention, even if only moderate: where nausea continued after the first 12 hours; and where the patient complained of intermittent abdominal pains, or other disturbing symptoms of whatever kind. We soon learned that this method permitted early determination of the existence or non-existence of obstruction, the degree of the hindrance, and perhaps the exact location and nature of the lesion. Furthermore, we were able to determine whether or not the obstruction was progressive. Continued experience with this means of diagnosis confirms our confidence in its value. We are thankful that postoperative ileus has in recent years become almost a rarity; nevertheless, it does surely occur occasionally in spite of all we can do. The technique I am about to describe will permit the recognition of these cases at an early stage, and save lives which would otherwise be lost.

The patient suspected of postoperative ileus need not be moved from his bed. The ordinary portable X-ray apparatus, which should nowadays be included in the equipment of every modern hospital, may be wheeled to the side of the bed, a large loaded plate-holder with intensifying screen slipped beneath the patient's back as he lies supine in the bed, and an anteroposterior exposure of the abdomen made in a few seconds while the patient holds his breath. The plate-holder and roentgen apparatus are then removed without further disturbance of the patient, the plate developed, and the findings made available within 15 or 20 minutes.

The developed roentgenogram will reveal at once whether there is any gas distention of the bowel, and, if so, whether the distention occurs in the small or in the large intestine. Enormous gas distention of the stomach is occasionally seen, and its absence immediately excludes postoperative gastric dilatation. Small and large intestine may be differentiated by the characteristic outlines of the gas areas. Recognition of the characteristic haustral markings of the colon will suggest the need of the colon tube and a small clysma to relieve the imprisoned gas. Equally characteristic is the appearance of the gas-distended coils in acute obstruction of the small bowel. The coils are more or less parallel and the caliber of the intestine is increased to 5, 6, 8, or even 10 centimeters in diameter. It is seen that the distention is not confined to a short segment of the intestine, but usually involves several meters. In the more serious type of cases the degree of distention is at once apparent and suggestive.

It should be remembered that the above observations are all made without any preparation of the patient whatsoever; it is usually not necessary to administer any opaque material at all. But, if the observation of the gas-filled bowel (without the ingestion of barium sulphate) does not give decisive information, time will be saved by proceeding at once to the administration of a small amount, say 15 to 20 grams, of barium sulphate in plain water, given in small, divided doses until the entire dose has been ingested. These cases are often so doubtful from the clinical standpoint that final decision as to operation is postponed in any case, and there is afforded ample time for some of the barium to pass on into the small intestine, in which case the intestinal picture is more characteristic. After a little experience, however, it is quite unnecessary to administer any barium at all by mouth, the decision being rendered on the appearance of the abdominal shadow with reference to the character and distribution of the gas areas which it may present.

This simple method of postoperative study is not more harmful to the patient than the manipulations necessary to the change of bed-linen, and I earnestly recommend its employment in all cases of suspected postoperative ileus.

In the above remarks I have tried to show how advantageously the roentgen rays may be called upon in a variety of conditions to assist the surgeon; but that the fullest value may be rendered in this service, close co-operation is required between surgeon and radiologist. In past years much of the time of the radiologist has been consumed in technical and laborious manipulations which may now be to a large extent carried out by technical assistants, and the time of the physician devoted to the more exclusively professional side of his work. It is also high time that the surgeon should familiarize himself with the field of radiological diagnosis and therapy. Only in this manner can successful co-operation be realized. "In union there is strength."

SOME COMMENTS ON THE SURGICAL TREATMENT OF HYPERTHYROIDISM

By JAMES T. CASE, M.D., F.A.C.S., Battle Creek, Michigan
Battle Creek Sanitarium

In general, it may be stated that the ultimate treatment in every well-marked case of hyperthyroidism is surgery. Some of the leading Fellows of the American College of Surgeons feel that all other means of management are only temporal, and sooner or later the patient must submit to operation. This is a general statement, and naturally there are some exceptions. It is to these that I wish to draw your attention during the brief time at my disposal, as well as to the newer methods of rendering the operation more safe when it is finally decided upon.

It is not necessary here to review the signs of the disease, but only to emphasize the fact that persistent tachycardia, even though not marked, persistent nervousness, excitability and tremor not explained by some other form of clearly defined nervous disease, persistent though slight suffusion of the face, should always direct attention to the thyroid gland, especially if a latent goiter has existed for several years. Indeed, it is not unusual for a tumor of the thyroid to have existed for several years without the development of recognizable symptoms; then some sudden and unexpected event in the patient's life, death of a relative, strong emotional excitement of any kind, accident, mental shock, etc., sets to work the obscure process in the gland which results in the production and absorption of some toxin, the exact nature of which is not yet well recognized, although various theories have been advanced. It is a fact that the toxin is developed within the gland, and that many simple goiters may develop into toxic goiters.

Attention should also be called to the variations in the clinical picture in a given case. It is a fact that remissions often occur, and should such happen coincidently with the application of any therapeutic measure whatever, the physician will naturally feel that his treatment was the curative means. There are also many cases where the pathological picture resembles simple goiter, and it is often difficult to make an exact differentiation between this type and true exophthalmic goiter.

The present working theory is that the toxæmia is due to the absorption of toxic products from degenerating areas within the gland, and the therapeutic indication is, therefore, definite for removal of the source of the toxæmia, the glandular tissue. If the operation is done early, the results are satisfactory; but if surgical intervention is delayed, irreparable damage may occur to the cardiorenal system. Nevertheless, even in deferred cases, with far advanced complications, operation is indicated where possible for the removal of the source of the intoxication. In some of these cases the operation, though late, may result in a partial degree of cure.

Early diagnosis is obviously of the highest importance. I need not take your time to enumerate the usually recognized means of diagnosis of hyperthyroidism; but I will permit myself to refer briefly to the estimate of the basal metabolism by the respiratory calorimeter method, with which we are well acquainted in the Battle Creek Sanitarium, where I have the honor to be surgeon and director of the department of radiology. One of the members of our staff, Dr. Paul Roth, was associated with Dr. Benedict, of Boston, in the development of the metabolism apparatus in portable form for clinical use. No city should be without at least one clinic where the basal metabolism may be estimated, and the technique is not so difficult that the work cannot be accurately done in any clinic. Neither is the expense so great as to prohibit the purchase and upkeep of the necessary equipment. In our institution, the basal metabolism is estimated as a matter of routine in all nervous patients, so-called neurasthenics, and the result of the test of metabolism is a great aid in differentiating hyperthyroidism from the various other diseases characterized by tachycardia. Especial interest is attached to the value of this method in distinguishing early tuberculosis from early hyperthyroidism.

It is important to make a thorough examination of the nose and throat for possible local foci of infection. In no small proportion of cases of mild hyperthyroidism, with beginning changes in the heart rhythm, removal of the tonsils or infected teeth, or adequate clearing up of sinus infection, cause a prompt drop in the metabolic rate and disappearance of the cardiac symptoms. Even in cases of well-marked organic disease, where a co-existing sinus, tooth or tonsil infection is detected, it is important to attend to these foci of infection before proceeding to radical operation on the thyroid gland; for the patient will thus have become much better able to withstand the thyroid operation.

Hot water injections have been extensively employed in various countries; but on the whole this treatment is attended by considerable danger and the results are not dependable.

Ligation of one or both of the superior thyroid arteries gives immediate results in most cases; but after a few months of remission, the hyperthyroidism gradually returns.

Radiotherapy has been employed for nearly 20 years in the treatment of hyperthyroidism, encouragement for this method emanating chiefly from internists who were seeking to find some non-

surgical method of cure. Undoubtedly many cases of definite hyperthyroidism, both of the hyperplastic and the non-hyperplastic types, have been favorably influenced by properly administered radiotherapy, and every radiologist of experience can relate several cases where the cure has been complete and permanent. Nevertheless, much opposition has been raised to this means of managing hyperthyroidism, some claiming that the beneficial effects of radiation were only temporary, the symptoms recurring within 3 or 4 months; others maintaining that actual damage is done the patient, making subsequent operation much more difficult if radiation fails.

My personal practice is the following: Radiation (meaning treatment either with the roentgen rays or with radium) is permitted for all cases of mild hyperthyroidism, where one hesitates to recommend surgical procedure (cases where the metabolic rate is between 15 and 25 or 30 plus); also when the metabolic rate is above 50, the irradiation being administered in the latter instance to depress thyroid activity definitely until a metabolic rate of 40 or lower, if possible, is obtained. The patient may then be operated upon with the greatest safety.

There is not a doubt that some of the patients thus treated return later with a reappearance of the symptoms; but even in these the irradiation has had an effect equal to ligation of one or both of the superior thyroid arteries. It is our custom to prefer one preliminary ray treatment as equal in value to the ligation of one artery. If it is the intention to manage the case entirely without surgery, then the ray treatment is repeated at monthly intervals until three or four series of treatments have been applied.

In most cases the symptoms abate immediately after the application of the first dose, so that at the time of the second application, one month later, there is a conspicuous improvement in the outstanding symptoms. The basal metabolic rate also diminishes, though not in proportion to the clinical improvement of the patient.

Again permit me to remark that at a later operation on one of these irradiated cases it is rare that any difficulty is found which can honestly be charged to the irradiation treatment. In my operative work on such patients I have sometimes encountered excessive bleeding due to numerous adhesions, but no more marked than I frequently note in goiter cases that have not been submitted to previous treatment of any kind whatever. I feel therefore that the objections to radiation therapy, even in cases which will probably have to come to operation later, are not as serious as some would have us believe. And, further, there is no doubt that many cases of hyperthyroidism may be brought to a happy conclusion without the necessity of operation. Many patients treated 6 to 12 years ago for hyperthyroidism have not had a recurrence.

Nevertheless it must also be admitted that surgical extirpation, under all the favorable conditions set forth by Crile and his associates, guided by the accurate metabolism measurements, offers the most dependable and immediately successful therapeutic measure in this disease, which, if neglected, is followed by such dire results.

CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

THIRTEENTH ANNUAL SESSION, CHICAGO, OCTOBER 22–26, 1923

HARVEY CUSHING, Boston, *President* — ALBERT J. OCHSNER, Chicago, *President-Elect*
FRANKLIN H. MARTIN, Chicago, *Director-General*

LOCAL EXECUTIVE COMMITTEE

ALLEN B. KANAVEL, *Chairman*

FREDERIC A. BESLEY	CHARLES DAVISON	HERMAN L. KRETSCHMER
JOHN A. CAVANAUGH	E. K. FINDLAY	PHILIP KREUSCHER
ARTHUR H. CURTIS	GILBERT FITZ-PATRICK	NELSON M. PERCY
CARL B. DAVIS	IRA FRANK	HERBERT A. POTTS

PLANS FOR THE CLINICAL MEETING IN CHICAGO

WEEK'S PROGRAM IN BRIEF

Monday, October 22

9–12. Hospital Conference, Gold Room, Congress Hotel. Papers and discussions.
2–5. Hospital Conference, Gold Room, Congress Hotel. Round table conference.
8. Presidential Meeting, Orchestra Hall. Inaugural address of President-Elect and Murphy Oration on Surgery.

Tuesday, October 23

9–12. Clinics and demonstrations at the hospitals and medical schools.
2–4. Clinics and demonstrations at the hospitals and medical schools.
4. Laying of cornerstone of Murphy Memorial.
8. Scientific session, Gold Room, Congress Hotel. Papers and discussions.

Wednesday, October 24

9–12. Clinics and demonstrations at the hospitals and medical schools.
2–5. Clinics and demonstrations at the hospitals and medical schools.
8. Scientific session, Gold Room, Congress Hotel. Papers and discussions.

Thursday, October 25

9–12. Clinics and demonstrations at the hospitals and medical schools.
2–4. Clinics and demonstrations at the hospitals and medical schools.
4. Annual meeting of the Fellows of the American College of Surgeons, Gold Room, Congress Hotel.
8. Scientific session, Gold Room, Congress Hotel. Papers and discussions.

Friday, October 26

9–12. Clinics and demonstrations at the hospitals and medical schools.
2–5. Clinics and demonstrations at the hospitals and medical schools.
8. Eleventh Convocation of the American College of Surgeons, Auditorium Theater.

IN the following pages will be found a preliminary program of clinics and demonstrations to be given at the thirteenth annual session of the Clinical Congress in Chicago, beginning Tuesday, October 23, and ending on Friday, October 26. This program is to be completely revised and amplified previous to the meeting to include all of the important medical institutions and clinicians of the city so that the final program will completely present the clinical activities of this great medical center. All departments of surgery will be represented therein: General surgery, gynecology, obstetrics, orthopedics, urology, surgery of the eye, ear, nose, throat, and mouth, experimental surgery, surgical pathology, roentgenology, etc. Clinical demonstrations or "dry clinics," in which the internists, pathologists, and others connected with the various institutions will participate, will provide interesting features of the program. The real program of the Congress, however, will be issued daily during the meeting and will be complete in detail as to the cases to be

operated upon and the demonstrations to be given.

The morning and afternoon hours of Monday are set apart for a conference on the hospital standardization program of the College and the problems related thereto. The program for the conference is in preparation and will consist of papers and discussions by surgeons, hospital superintendents, nurses, trustees, and others interested in the conduct of hospitals.

Dr. Albert J. Ochsner, president-elect, will be inaugurated and deliver the annual address at the presidential meeting to be held in Orchestra Hall on Monday evening. The distinguished visitors from foreign countries will be introduced at this meeting.

On Tuesday, Wednesday, and Thursday evenings in the Gold Room of the Congress Hotel will be held a series of scientific meetings, the programs for which are being prepared by the executive committee of the Congress. Papers dealing with surgical subjects of timely interest will be read and discussed by eminent surgeons of the United States and Canada and distinguished visitors from Europe and South America.

On Friday evening in the Auditorium, at the eleventh convocation of the American College of Surgeons, fellowship in the College will be conferred upon a group of American and Canadian surgeons and honorary fellowship upon the distinguished foreign guests.

General headquarters for the Congress will be established at the Congress Hotel where the Ballroom, Florentine, Elizabethan, and St. Francis rooms, together with the foyers and other rooms adjacent thereto on the first and second floors, have been reserved for the exclusive use of the Congress. These rooms will be utilized for evening meetings, registration and ticket bureaus, bulletin rooms, etc.

An application for reduced railway rates on account of this meeting is pending with the railway passenger associations and it seems assured that a substantial reduction in fares will be granted, applying to all portions of the United States and Canada.

LIMITED ATTENDANCE—ADVANCE REGISTRATION

Because of the popularity of these annual clinical meetings it has been found necessary in recent years to adopt the plan of limiting attendance. This plan necessitates registration in advance on the part of all who wish to attend. The limit of attendance is based upon the result of a survey of the amphitheaters, lecture rooms, and laboratories in the several hospitals and medical schools as to their capacity for accommodating visitors. When the limit of attendance has been reached through advance registration no further applications will be accepted, hence the necessity for early registration. It is to be expected that the limit of attendance will be reached some weeks in advance of the meeting.

CLINIC TICKETS

Attendance at all clinics and demonstrations is controlled by means of special clinic tickets, which are issued at headquarters each morning at 8 o'clock for that day's clinics. The use of clinic tickets has proven an efficient means of providing for the distribution of the visiting surgeons among the several clinics and insuring against overcrowding, as the number of tickets issued for any clinic is limited to the capacity of the room in which that clinic is to be given.

A complete detailed schedule of the day's clinics will be posted on bulletin boards at headquarters during the afternoon of the preceding day. After the program has been so posted, reservations for tickets for the next day's clinics may be filed, the tickets to be issued the following morning at 8 o'clock. A printed program will be issued each morning which will contain the complete clinical program for the day, with announcements of evening sessions and other information.

REGISTRATION FEE

In order that no financial burden may be imposed upon the members of the profession in the city entertaining the Congress, a registration fee of $5.00 is required of each surgeon attending the clinical meeting, such fee providing the funds with which to meet the expenses of conducting the meeting. A formal receipt for the registration fee is issued to each surgeon registering in advance which receipt is to be exchanged for a general admission card upon his registration at headquarters. This card, which is non-transferable, must be presented to secure clinic tickets and for admission to the evening meetings.

PRELIMINARY CLINICAL PROGRAM

COOK COUNTY HOSPITAL

Operative clinics, daily, morning and afternoon. Pathological conference, daily, 11. Clinical demonstrations will be given as follows:

F. A. BESLEY—Sarcoma of the extremities, with exhibit of cases.
W. R. CUBBINS—Indications for enterostomy in intestinal obstruction.
VERNON DAVID—Osteomyelitis in children; also local recurrence in carcinoma of the rectum.
GEORGE DAVENPORT—Demonstraton: Ventriculography in brain lesions.
G. G. DAVIS—Injuries of the spine and spinal cord.
F. G. DYAS—Carcinoma of the stomach.
D. N. EISENDRATH—Cases illustrating surgery of the kidney and ureter.
HARRY JACKSON—Rôle of intracranial pressure in injuries of the brain and skull.
E. J. LEWIS—Early management of compound fractures.
HUGH MCKENNA—Cases of fracture of the neck of the femur.
R. W. MCNEALY—Aneurism of the aorta and peripheral vessels.
KARL MEYER—Acute perforating ulcers of the stomach.
PAUL OLIVER—Carcinoma of the breast.
K. SPEED—Standardization of fracture treatment; arthroplasty.
D. C. STRAUS—Diagnosis and treatment of cholecystitis and cholelithiasis.
GEORGE THOMPSON—Common duct stones.
R. T. VAUGHAN—Lung abscess.

MERCY HOSPITAL

Tuesday, October 23

J. F. GOLDEN, C. F. SAWYER, and E. L. MOORHEAD—9. General surgery.
G. W. MAHONEY—9. Eye clinic.
E. L. MOORHEAD—2. General surgery.
H. DOOLEY—2. Genito-urinary clinic.

Wednesday, October 24

PHILIP H. KREUSCHER—9. Bone and joint cases.
E. L. MOORHEAD and F. E. PIERCE—9. General surgical operations.
HENRY SCHMITZ—9. Gynecological clinic.
R. J. TIVNEN—9. Eye, ear, nose, and throat clinic.
JOHN D. CLARIDGE—2. Bone and joint cases.
C. LARKIN—2. General surgery.

Thursday, October 25

E. L. MOORHEAD and C. F. SAWYER—9. General surgical operations.
PHILIP H. KREUSCHER—9. Bone and joint cases.
R. J. TIVNEN—Eye, ear, nose, and throat clinic.
H. DOOLEY—2. Genito-urinary clinic.

Friday, October 26

PHILIP H. KREUSCHER—9. Special arthroplasty clinic.
HENRY SCHMITZ—9. Gynecological clinic.
JOHN F. GOLDEN—9. General surgery.

Daily

STAFF—9–5. Out-patient clinics.
STAFF—X-ray demonstrations.

WESLEY MEMORIAL HOSPITAL

Tuesday, October 23

MARK T. GOLDSTINE—9. Vaginal plastics.
STAFF—2. Dry clinic: J. GORDON WILSON—Differentiation between labyrinthine and cerebellar disease. OTIS H. MACLAY—Ethmoid infections. C. B. YOUNGER—Sinus infections. C. F. BOOKWALTER—The intranasal operation on the tear sac.

Wednesday, October 24

ALLEN B. KANAVEL—9. Brain tumor. Plastics on the hands and face. Goiter.
JOHN A. WOLFER—2. Gastric surgery.

Thursday, October 25

WILLIAM E. SCHROEDER—9. Breast tumors. Kidney surgery.
PAUL B. MAGNUSON—2. Bone grafts in the spine. Operations on old fractures of the os calcis. Injuries about the shoulder, elbow, and wrist joint.

Friday, October 26

H. M. RICHTER—9. Gall-bladder diseases. Goiter and stomach cases.
V. D. LESPINASSE—2. Sterility cases.
CHARLES B. REED—3:30. Measurements of the fetus in utero. Induction of labor and bag work.

AUGUSTANA HOSPITAL

Tuesday, October 23

N. M. PERCY—9. General surgery.
DENNIS W. CRILE—2. Fracture clinic.

Wednesday, October 24

A. J. OCHSNER—9. General surgery.
E. H. OCHSNER—9. General surgery.
RUDOLPH ODEN—2. General surgery.
RUDOLPH HOLMES—3:30. Obstetrical clinic.

Thursday, October 25

N. M. PERCY—9. General surgery.
JOHN NUZUM—2. General surgery.

Friday, October 26

A. J. OCHSNER—9. General surgery.
E. H. OCHSNER—9. General surgery.
ALFRED MURRAY—2. Sinus clinic.

ST. LUKE'S HOSPITAL

A. E. HALSTEAD, L. L. MCARTHUR, and W. M. HARSHA—General surgery.
J. L. PORTER and E. W. RYERSON—Orthopedic clinic.
T. J. WATKINS and A. H. CURTIS—Gynecological clinic.
R. B. PREBLE, J. A. CAPPS, and A. R. ELLIOTT—Medico-surgical cases.

LYING-IN HOSPITAL

J. B. DELEE, D. S. HILLIS, D. F. MONASH, E. L. CORNELL, D. A. HORNER, and ANNA R. LAPHAM—Daily, 2. Obstetrical clinic.

CHILDREN'S MEMORIAL HOSPITAL

Tuesday, October 23

ALBERT H. MONTGOMERY—2. General surgery.
THOMAS GALLOWAY—2. Nose and throat clinic.

Wednesday, October 24

M. HANCHETT—9. General surgical operations.
WALTER C. BURKET—2. General surgery.
EDWIN W. RYERSON and ROBERT O. RITTER—3. Orthopedic operations.

Thursday, October 25

THOMAS GALLOWAY—10:30. Nose and throat operations.
EDWIN MILLER and ERNEST MCGILL—2. General surgery.
JOHN C. WILLIAMS—2. Nose and throat clinic.

Friday, October 26

ALBERT H. MONTGOMERY—9. General surgical operations.
M. HANCHETT—2. General surgery.
EDSON FOWLER—3. Orthopedic clinic.

MICHAEL REESE HOSPITAL

D. N. EISENDRATH—Kidney and bladder operations with demonstration of cases.
L. A. GREENSFELDER—Thyroid clinic, operations and demonstration of cases.
EMANUEL FRIEND—Gall bladder operations with demonstration of cases.
D. C. STRAUSS—Fracture and osteomyelitis cases, operations and demonstration of (a) recent advances in the treatment of fractures and osteomyelitis with special reference to children; (b) advances in the diagnosis of gall-bladder disease and its surgical treatment.
GEORGE L. DAVENPORT—Ventriculography; brain tumor operations; demonstration of cases with technique of ventriculography.
ALFRED A. STRAUSS—Operations on the stomach with demonstration of stomach and intestinal cases.
RALPH BETTMAN—Thoracic surgery with demonstration of cases.
HARRY JACKSON—Operations and demonstration of management of acute cranial injuries.
EDMUND ANDREWS—Hernia clinic, operations and demonstration of cases.
CHARLES JACOBS—Orthopedic clinic, operations and demonstration of cases.
M. A. BERNSTEIN—Orthopedic clinic, operations and demonstration of cases.
JAMES PATEJDL—Orthopedic clinic, operations and demonstration of cases.
ROBERT A. ARENS—Demonstrations in X-ray department: (a) Recent advances in the new high-voltage treatment of surgical cases with special reference to precise methods of measuring X-ray quantity; (b) cases of sarcoma treated by the higher voltage; (c) exhibit of plates showing surgical lesions.
L. E. FRANKENTHAL—Operations for incontinence and complete laceration, with demonstration of cases.
L. SIMON—Obstetrical operations, with demonstration of cases.
JOSEPH L. BAER—Adnexal disease, toxæmias of pregnancy, capillaroscopy, obstetrical operations.
IRVING STEIN—Uterine tumors; pneumoperitoneum, transuterine and transabdominal.
WILLIAM RUBOVITZ—Operations for prolapse, obstetrical operations.
JULIUS LACKNER—Vesico-vaginal and recto-vaginal fistulas; obstetrical operations.
L. E. SCHMIDT, G. KOLISCHER, I. S. KOLL, J. S. EISENSTAEDT, and H. KATZ—Genito-urinary clinic, operations and demonstration of cases.
M. L. GOODKIND—Medico-surgical cases.
J. C. FRIEDMAN—Gastroduodenal ulcer, symptomatology and diagnosis.
S. STROUSE—Use of Insulin in preparation of diabetics for operation.
D. SCHRAM—Heart pathology in chronic intoxications, particularly diabetes.
J. MEYER—Splenomegalic hæmolytic jaundice, surgical significance.
I. PILOT—Lung abscess and gangrene following general anæsthesia.
WILLIAM A. BRAMS—Unusual forms of gastric ulceration.
W. W. HAMBURGER—Rate of electrocardiography in surgical diagnosis and prognosis.
HARRY KAHN—Tuesday and Thursday, 9. Ultra-violet rays in diseases of the nose and throat.
ROBERT SONNENSCHEIN—Thursday and Friday, 9. Nose and throat clinic.
JEROME STRAUSS—Wednesday, 2. Nose and throat clinic.
IRA FRANK—Thursday, 2. Nose and throat clinic.

NELSON MORRIS INSTITUTE FOR RESEARCH

O. T. SCHULTZ—Pathological demonstrations.
B. PORTIS—Protective mechanisms of the omentum.
W. BLOOM—Experimental studies in obstructive jaundice.
W. H. ROSENAU—Clinical and experimental studies on liver function.

CHICAGO MEMORIAL HOSPITAL

Tuesday, October 23

DAVID S. HILLIS and J. E. FITZGERALD—9. Obstetrical clinic.
JULIA C. STRAWN and A. E. KANTER—10. Gynecological clinic.
STAFF—2. Eye, ear, nose, and throat clinic

Wednesday, October 24

H. R. CHISLETT, CHARLES E. KAHLKE, PETER S. CLARK, R. A. MELENDY, P. M. OLIVER, and W. M. HANCHETT—9. General surgical clinic.
D. N. EISENDRATH, J. M. MALTMAN, and D. G. BRUNJES—11. Genito-urinary clinic.

Thursday, October 25

DENNIS W. CRILE—9. Orthopedic clinic.
JULIA C. STRAWN, A. E. KANTER, DAVID S. HILLIS, and J. E. FITZGERALD—11. Gynecological and obstetrical clinic.
STAFF—2. Eye, ear, nose, and throat clinic.

Friday, October 26

STAFF—9. Presentation of borderline cases from all departments.

NORTH CHICAGO HOSPITAL

CARL BECK, EMIL G. BECK, J. FREDERICK HARVEY—General surgery.
JOSEPH C. BECK, HARRY L. POLLOCK, FRANCIS L. LEDERER—Eye, ear, nose, and throat operations, and demonstration of cases.
BENJAMIN H. ORNDOFF and staff—Diagnosis of surgical and medical cases with special reference to the use of the X-ray and pneumoperitoneum.

ST. JOSEPH'S HOSPITAL

Tuesday, October 23

HUGH MCKENNA—9. Inguinal hernia, appendectomy, gall bladder, bone transplant for non-union, demonstration of author's fracture table.

A. A. HAYDEN—9. Stacke operation for chronic purulent mastoiditis; suture of pillars for control of hæmorrhage in tonsillectomy; demonstration of head bandages; correction of external nasal deformities.

CHARLES MCKENNA—10. Vasotomy, inguinal hernia, prostatectomy.

TRUMAN BROPHY—10. Cleft palate and hair-lip cases

Wednesday, October 24

THOMAS O'DONOHUE—9. Demonstration: Cases of resection of sigmoid for malignancy with X-ray pictures before and after operation; cases of multiple diverticulitis of large bowel.

FRANK DAVID—9. Hæmorrhoids, fistula of rectum.

OSCAR OFNER—10. Conservative or radical treatment of inflammatory adnexa of the uterus.

W. GROSVENOR, FRED ROHR, and L. W. MARTIN—Demonstration of obstetrical technique with manikin.

DAVID FITZGERALD—10. Abdominal and gynecological operations.

W. H. G. LOGAN—10. Cleft palate and hair-lip cases.

Thursday, October 25

HUGH MCKENNA and CLEMENT DE BERR—9. End-results in fracture cases and blood transfusion in chronic bone infection cases.

FRANK B. MCCARTHY—10. Abdominal operations.

J. HOLINGER—10. Bexold mastoid operation.

J. Z. BERGERON—9. Canfield antrum operation, frontal sinus operation, tonsillectomies.

A. A. HAYDEN—2. Stacke operation for chronic purulent mastoiditis; suture of pillars for control of hæmorrhage in tonsillectomy; demonstration of head bandages; correction of external nasal deformities.

Friday, October 26

A. A. HAYDEN—9. Stacke operation for chronic purulent mastoiditis; suture of pillars for control of hæmorrhage in tonsillectomy; demonstration of head bandages; correction of external nasal deformities.

SPECIAL DEMONSTRATIONS

L. E. HINES—The pathology in a case of heart disease associated with pregnancy.

WILLIAM H. BURMEISTER, LELAND SHAFER, and F. O. FREDERICKSON—Medico-surgical cases with fluoroscopy of the chest and following bismuth meals.

E. L. JENKINSON—Daily, 3. X-ray therapy.

LOYOLA UNIVERSITY MEDICAL SCHOOL

Tuesday, October 23

LLOYD ARNOLD—2. Special demonstration in pathology and bacteriology.

Wednesday, October 24

M. T. STRONG and T. T. JOBE—2. Special demonstration in anatomy.

Thursday, October 25

S. A. MATTHEWS—2. Special demonstration in physiology.

Friday, October 26

W. C. AUSTIN—2. Special demonstration in chemistry.

COLUMBUS HOSPITAL

Tuesday, October 23

J. R. PENNINGTON—9. Rectal diseases

M. M. RITTER—11. Eye, ear, nose, and throat clinic.

W. H. O. HOFFMAN—2. Pediatric clinic.

S. R. PIETROWICZ—3. Medico-surgical cases.

J. DAMIANI—4. Roentgenological diagnosis.

Wednesay, October 24

DANIEL A. ORTH, W. B. GERHARD, T. A. CARTER, WILLIAM SADLER, M. J. SEIFERT, and L. C. QUINN—9. General surgical clinic.

J. E. H. ATKEISSON—2. Anæsthesia.

W. H. GEHL—3. Genito-urinary surgery.

C. W. BARRETT—4. Gynecological clinic.

Thursday, October 25

FREDERICK MUELLER—9. Orthopedic clinic.

LENA SADLER—11. Gynecological and obstetrical clinic.

O. W. MCMICHAEL—2. Medico-surgical cases.

HAROLD MOYER—3. Neuro-surgical cases.

C. O. GETTY—4. Laboratory demonstrations.

Friday, October 26

DANIEL A. ORTH, W. B. GERHARD, T. A. CARTER, WILLIAM SADLER, M. J. SEIFERT, and L. C. QUINN—9. General surgical clinic.

C. O. LINDSTROM—2. Eye, ear, nose, and throat clinic.

JOSEPH WELFELD—3. Dermatology.

L. P. KUHN—4. Industrial surgery.

Daily at 8:30

Emergency drill by surgical nurses.

WOMEN'S AND CHILDREN'S HOSPITAL

Tuesday, October 23

MARY G. MCEWEN and ANNA BLOUNT—9. General surgery.

MARGUERITE JONES and NORA RAGER—9. Nose and throat clinic.

BERTHA SHAFER—2. Syphilis clinic.

EFFA V. DAVIS, RHODA P. BARSTOW, and JOHANNA HEUMANN—3. Pediatric clinic.

Wednesday, October 24

LENA K. SADLER and JULIA STRAWN—9. General surgery.

LILLIAN E. TAYLOR and GERTRUDE THOMPSON—9. Nose and throat clinic.

SARAH M. HOBSON, CLARA FERGUSON, ARMINA HILL, MARIE ORTMAYER, and ELIZA MORSE—2. Medico-surgical clinic.

Thursday, October 25

ALICE CONKLIN—9. General surgery.

KATHERINE B. RICH and ROSE Z. BENNET—9. Nose and throat clinic.

STAFF—2. Cancer clinic: MAUD SLYE—Heredity of cancer. HELEN B. FLYNN—Infection of cancer and serum treatment. MARY E. HANKS—X-ray treatment of cancer. WALBURGA KACIN—Emetin treat ment in cancer. Radium treatment

Friday, October 26

BERTHA E. BUSH and MARY J. KEARSLEY—9. General surgery.

JANE F. BEEM and H. STEPHENS WALKER—9. Nose and throat surgery.

RACHEL S. YARROW, PEARL M. STETLER, VESPER R. SHAFFER, LOUISE ACRES, HELGA RUUD—2. Obstetrical clinic. Demonstration of twilight sleep.

UNIVERSITY HOSPITAL

Tuesday, October 23

E. V. L. BROWN—9. Eye clinic.
C. C. ROGERS—10. General surgery.

Wednesday, October 24

HARRY CULVER—9. Urological clinic.
CHARLES DAVISON—10. General surgery, cases of undescended testicle.
CHARLES DAVISON—2. General surgery.

Thursday, October 25

J. P. SPRAGUE—9. Orthopedic surgery.
KARL A. MEYER—10. General surgery, gastro-intestinal cases.

Friday, October 26

WILLIAM E. GAMBLE—9. Eye clinic.
C. S. BACON—10. Obstetrical clinic.

ST. MARY'S HOSPITAL

Tuesday, October 23

D. A. ORTH and GEORGE MUELLER—9. General surgery.
H. SCHMITZ, H. BUNDY, and J. LAIBE—9. Radium clinic.
F. B. LUSK—2. Laboratory demonstrations.
C. CHALLENGER—2. X-ray demonstrations.

Wednesday, October 24

N. M. PERCY, O. E. NADEAU, W. A. KEWFLEWSKI, and T. Z. XELOWSKI—9. General surgery.
J. J. KILLEEN—2. Ear, nose, and throat clinic.
G. W. MAHONEY—2. Eye clinic.

Thursday, October 25

A. J. OCHSNER, D. A. ORTH, GEORGE MUELLER, and O. E. NADEAU—9. General surgery.
S. R. PIETROWICZ—9. Medico-surgical cases.
D. W. CRILE—2. Orthopedic clinic.

Friday, October 26

R. E. FLANNERY, E. PATERA, M. J. SEIFERT, and C. STOTZ—9. General surgery.
E. K. BATHOLOMEW—9. Medico-surgical cases.
J. WELFELD—2. Genito-urinary and skin clinic.

RAVENSWOOD HOSPITAL

Tuesday, October 23

DARWIN POND—9. General surgery. Fracture cases.

Wednesday, October 24

CLARK A. BUSWELL—9. General surgery. Laparotomies, tonsillectomies.

Thursday, October 25

G. W. GREEN and G. N. BUSSEY—9. General surgery. Goiter cases and laparotomies.

MT. SINAI HOSPITAL

H. M. RICHTER—Surgery of the thyroid and the bile tracts.
V. L. SCHRAGER—Abdominal surgery, hernia cases.

ST. ANNE'S HOSPITAL

B. W. MACK, GEORGE W. POST, JR., H. J. DOOLEY and associates—Daily, 9. General surgery.

EYE AND EAR INFIRMARY

Tuesday, October 23

M. GOLDENBURG and R. VON DER HEYDT—2. Eye clinic.
H. R. BOETTCHER—2. Ear, nose, and throat clinic.

Wednesday, October 24

D. C. ORCUTT—2. Eye clinic.
N. H. PIERCE—2. Ear, nose, and throat clinic.

Thursday, October 25

E. K. FINDLAY—2. Eye clinic.
U. J. GRIM—2. Ear, nose, and throat clinic.

Friday, October 26

H. W. WOODRUFF—2. Eye clinic.
S. M. HAGER—2. Ear, nose, and throat clinic.

ST. ANTHONY'S HOSPITAL

Tuesday, October 23

LAWRENCE RYAN—9. Plastic surgery, operative clinic.
F. J. E. EHRMANN, JOSEPH ZABOKRTSKY, and S. E. DONLON—2. General surgical clinic.

Wednesday, October 24

F. J. E. EHRMANN, JOSEPH ZABOKRTSKY, and S. E. DONLON—9. General surgical operations.
LAWRENCE RYAN—2. Dry clinic, plastic surgery.
EVELYN EHRMANN and F. B. OLENTINE—2. Laboratory demonstrations.

Thursday, October 25

LAWRENCE RYAN, R. C. CUPLER, JOSEPH ZABOKRTSKY, and F. B. OLENTINE—9. General surgical operations.
OTTO JIRSA—2. Demonstration of genito-urinary cases.
L. S. TICHY—2. X-ray demonstration.

Friday, October 26

J. E. STANTON, F. J. FARA, ROBERT HARDIE, and J. C. STUBBS—9. Staff meeting with presentation of cases.
JOHN THEOBALD and H. M. THOMETZ—2. Nose and throat clinic.
MAX WEISSKOPF—2. Obstetrical clinic.

LUTHERAN DEACONESS HOSPITAL

Tuesday, October 23

E. E. HENDERSON and G. H. SCHROEDER—9. General surgery, diagnostic and operative clinic.

Wednesday, October 24

S. DAHL—9. General surgery.
I. PILOT—9. The habitat and distribution of hæmolytic streptococci and their rôle in surgical infections.

Thursday, October 25

A. E. KANTER—9. Gynecological clinic.

Friday, October 26

E. E. HENDERSON and G. H. SCHROEDER—9. General surgery, diagnostic and operative clinic.
R. HOUSEHOLDER—9. X-ray diagnosis of surgical conditions.

FRANCES WILLARD HOSPITAL

Tuesday, October 23

FRENCH CARY—2. Genito-urinary clinic.

Wednesday, October 24

FRANK D. MOORE—2. General surgery.

Thursday, October 25

VICTOR L. SCHRAGER—2. General surgery.

PRESBYTERIAN HOSPITAL

A. D. BEVAN, DEAN LEWIS, CARL B. DAVIS, D. B. PHEMISTER, GATEWOOD, V. C. DAVID, H. L. KRETSCHMER, R. H. HERBST, G. L. MCWHORTER, EDWARD MILLER, A. H. MONTGOMERY, F. B. MOOREHEAD, C. A. PARKER—General surgery, urology, orthopedics.

N. S. HEANEY, CAREY CULBERTSON, W. F. HEWITT—Gynecological clinics.

W. H. WILDER and assistants—Eye clinics.

G. E. SHAMBAUGH and assistants—Nose and throat clinics

CHICAGO HOTELS AND THEIR RATES

While the hotels of Chicago have a large capacity for the entertainment of visitors, it is well for those expecting to attend the Congress to make reservation of hotel accommodations at the earliest possible date. The following hotels are recommended by the local committee:

	Minimum Rate Single Room			Minimum Rate Single Room	
	With Bath	Without Bath		With Bath	Without Bath
Atlantic	$3.50	$2.00	Edgewater Beach	$3.00	$....
Auditorium	5.00	2.50	Fort Dearborn	2.45	1.95
Blackstone	5.00	4.00	Great Northern	3.50	2.50
Brevoort	3.00	2.00	LaSalle	4.00	2.50
Chicago Beach	4.00	3.00	Lexington	3.00	2.00
Congress	4.00	3.00	Morrison	4.00	....
Cooper-Carlton	3.50	....	Planters	3.00	2.00
Drake	5.00	....	Sherman	3.00	2.00

STATE AND PROVINCIAL SECTIONAL MEETINGS OF THE CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

THE Sectional Meetings of the American College of Surgeons for the coming autumn season will be conducted as follows:

MANITOBA

The Sectional Meeting for the province of Manitoba is to be held this year in Winnipeg on September 10 and 11. The various sessions will cover a period of two days and will include a Hospital Standardization Meeting on the afternoon of the first day, and a Community Health Meeting in the evening, to which everyone is invited.

Dr. Daniel S. MacKay, of Winnipeg, is Chairman of the Provincial Committee, Dr. Gordon S. Fahrni, of Winnipeg, is Secretary, and Dr. Jasper Halpenny, of Winnipeg, is Counsellor.

The committee is putting forth every effort to see that this year's Sectional Meeting is the best which the College has ever had in Manitoba. Clinics are to be conducted at the local hospitals and a Scientific Session on the second afternoon.

ALBERTA AND SASKATCHEWAN

The Sectional Meeting for these two provinces is to be held in Edmonton on the 14th and 15th of September next. The headquarters and registration will be at the MacDonald Hotel where the Hospital Standardization and Scientific Meetings will also be conducted. The Public or Community Health Meeting on the night of the 14th, will be a very attractive one. Clinics are to be conducted at the local hospitals.

The Committee on Arrangements is sparing no effort in making this coming meeting very profitable to everyone who attends.

The Provincial Committee is composed of Dr. F. W. Gershaw, of Medicine Hat, Chairman, and Dr. A. R. Munroe, of Edmonton, Secretary.

MONTANA AND NORTH DAKOTA

The Montana and North Dakota Sectional Meeting of the American College of Surgeons will be held in Great Falls on September 18 and 19. Announcement of this meeting and place of registration will shortly be sent to all the Fellows of the College in these two states.

The Public Meeting will be held on the night of the 18th.

The State Committee of Montana is composed of Dr. Fred F. Attix, of Lewistown, Chairman; Dr. James H. Irwin, of Great Falls, Secretary; and Dr. Rudolph Horsky, of Helena, Counsellor. This committee will spare no effort to make the Sectional Meeting in Montana one of the very best.

OREGON AND IDAHO

The Sectional Meeting for the states of Oregon and Idaho will be held in Portland on the 24th and 25th of September. Elaborate arrangements are being carried out to make this one of the largest meetings which the College has ever had. Fellows of the College from the states of California and Nevada have also been invited.

The Public Meeting will be held on the night of the 24th and an excellent program is being provided.

The State Committee for Oregon is composed of Dr. E. F. Tucker, of Portland, Chairman; Dr. J. A. Pettit, of Portland, Secretary; and Dr. William B. Holden, of Portland, Counsellor.

Dr. E. A. Sommer, of Portland, is actively engaged in assisting this committee in its arrangements for the Sectional Meeting.

BRITISH COLUMBIA AND WASHINGTON

The Sectional Meeting for the province of British Columbia and the state of Washington will be held in Victoria, B. C., on September 28 and 29. Headquarters will be at the Empress Hotel.

The Public Meeting will be held on the night of the 28th and will be of interest to both laymen and doctors. An excellent group of speakers is engaged for this meeting. Clinics will be conducted in the local hospitals and the Hospital Standardization Meeting will be held at the Empress Hotel on the first day. The Scientific Meeting will be held on the afternoon of the second day.

Local arrangements are in charge of a committee with Dr. H. M. Robertson as Chairman, and Dr. D. W. Graham, as Secretary.

The Provincial Committee for British Columbia is composed of Dr. W. B. Burnett, of Vancouver, Chairman; Dr. A. B. Schinbein, of Vancouver, Secretary; and Dr. J. J. Mason, of Vancouver, Counsellor.

COLORADO, UTAH, WYOMING, AND ARIZONA

The Sectional Meeting for these states will be held in Denver, October 4 and 5. Headquarters and registration will be at the Brown Palace Hotel. Arrangements are in charge of a local committee with Dr. Oliver Lyons as Chairman. The Fellows of the College have all joined together to make this a most successful meeting.

It is expected that the Community Health Meeting will be very largely attended and an excellent program is being prepared. The Hospital and Scientific Meetings will be held at the Brown Palace Hotel. Clinics will be conducted at the local hospitals.

These meetings, it is noted, are practically all in the Northwest and will complete the Group Meetings for the year ending with the Clinical Congress, to be held in Chicago in October, 1923.

In the month of November, Sectional Meetings will be held for the states of Michigan, Ohio, Illinois, Indiana, Wisconsin, and the provinces of Ontario and Quebec.